USDA Forest Service
Research Paper RM-107
May 1973
Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture
Fort Collins, Colorado

Hydrologic Simulation Model of Colorado Subalpine Forest

by Charles F. Leaf and Glen E. Brink

Abstract

A simulation model specifically designed to determine the probable hydrologic changes resulting from watershed management in the Colorado subalpine zone is described. The model simulates the total water balance on a continuous year-round basis and compiles the results from individual hydrologic response units into a "composite overview" of an entire drainage basin. Preliminary results are summarized for an 8-year test period on a 667-acre experimental watershed.

Oxford: 116.21:U681.3. **Keywords:** Computer models, coniferous forest, forest management, model studies, simulation analysis, snowmelt, subalpine hydrology, vegetation effects, watershed management.

USDA Forest Service
Research Paper RM-107

May 1973

Hydrologic Simulation Model of Colorado Subalpine Forest

by

Charles F. Leaf, Hydraulic Engineer
and
Glen E. Brink, Computer Programer

Rocky Mountain Forest and Range Experiment Station[1]

[1]*Central headquarters maintained at Fort Collins in cooperation with Colorado State University. Research was conducted and partly financed in cooperation with the Division of Atmospheric Water Resources Management, Bureau of Reclamation, U.S. Department of the Interior.*

Contents

Hydrologic Simulation Model of Colorado Subalpine Forest

Charles F. Leaf and Glen E. Brink

Leaf and Brink (1973) have previously described a model for simulating snowmelt in central Colorado subalpine watersheds. Snowmelt over an area is described in terms of combinations of aspect, slope, elevation, and forest cover composition and density.

The hydrologic model described in this report is an expanded version of the snowmelt model. The model has been programed for the CDC 6400 computer at Colorado State University. It is designed to simulate the total water balance on a continuous, year-round basis, and to compile the results from individual hydrologic subunits into a "composite overview" of an entire watershed. The model has been designed to simulate watershed management practices and their resultant effects on the behavior of hydrologic systems. The model consists of (1) a "core" which performs the actual simulation, and (2) peripheral routines which specify hydrologic subunit parameters, obtain the input data, maintain continuity between simulation intervals, and output the results.

Figure 1 schematically shows the general flow of the model. Detailed flow chart descriptions of the water balance routines and pertinent hydrologic theory are presented in this report. Those routines which were incorporated from the snowmelt model without significant changes are not discussed here. Complete descriptions of the unrevised routines are given in Leaf and Brink (1973). The routines which were taken from the snowmelt model and

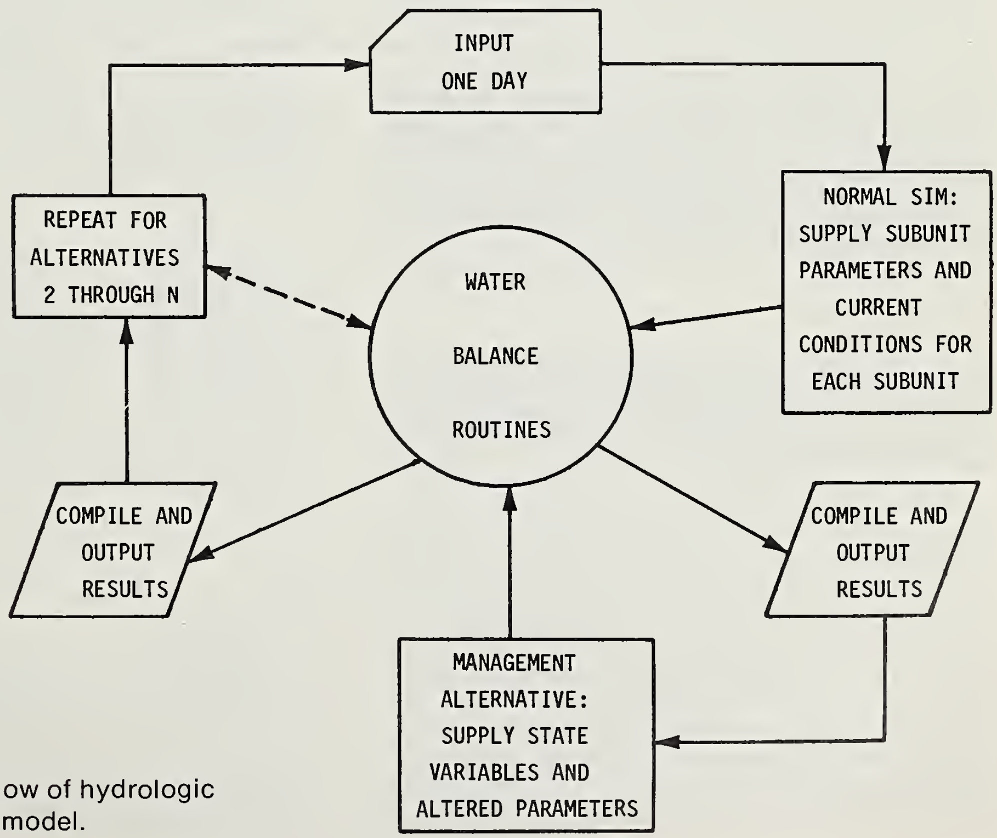


Figure 1. — General flow of hydrologic simulation model.

altered for compatibility with the water balance model are indicated by an asterisk (*) in the following tabulation.

Discussed in this report

WATBAL*
CANVAP
SNOWVAP
EVTRAN
RADBAL*
SNOWED*

Discussed in Leaf and Brink (1973)

AFFECTS
CALIN
CALOSS
DIFMOD
GETREF (now PACKREF)
LINK
MIXTURE
RAINED

Subroutine WATBAL (fig.2)

Subroutine AFFECTS from the snowmelt model (Leaf and Brink 1973) was expanded to include the decisions relating to evapotranspiration, and was renamed WATBAL. WATBAL is the primary routine in the water balance model. It receives input on a daily basis, the subunit parameters, and all state variables computed by the peripheral routines. (The only links between WATBAL and the peripheral routines are common block /WATRBAL/ and the formal parameters passed at the time of the call.)

Precipitation

Precipitation (if any) is classified as discussed in AFFECTS (Leaf and Brink 1973), and the degree to which it affects the energy balance is calculated.

Evapotranspiration

Morton (1971) points out that "the relationship between potential evaporation and regional (actual) evaporation includes the effects of hydrologic and climatologic feedback." The feedback includes moisture supply and the thermal and moisture characteristics of the overlying air, which are influenced by the actual evapotranspiration. This interaction in turn has a significant influence on the energy available for evapotranspiration.

These interactions have also been taken into account by Bouchet (1963), who argued that changes in regional and potential evaporation due to changes in regional moisture supply are complementary. If the potential evapotranspiration (ET) is computed from regional climatological observations and utilized in this concept, the regional (actual) evapotranspiration, which is a product of complex climatic, soil moisture, and vegetative processes may be estimated.

Of the several empirical methods available for computing potential evapotranspiration, the one developed by

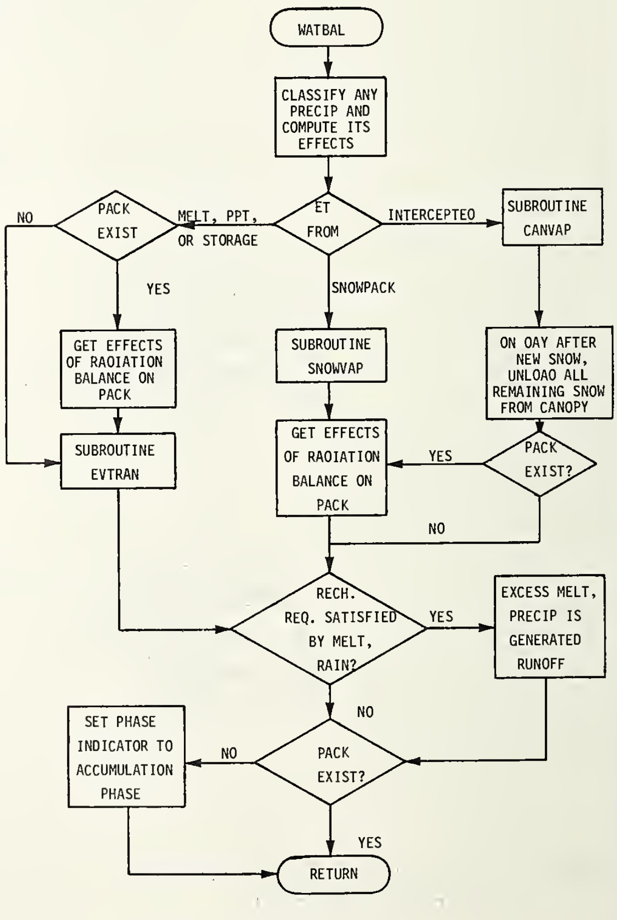


Figure 2. — Subroutine WATBAL.

Hamon (1961) appears to give the best results (Stephens and Stewart 1963, Russell and Boggess 1964, Takhar and Rudge 1970). Hamon formulated the expression:

$$E_h = CD^2P_t \qquad [1]$$

for computing average potential evapotranspiration, E_h (inches/day), for each month of the year
where

D = possible sunshine in units of 12 hours,
P_t = The saturated water vapor density (absolute humidity) at the daily mean temperature in grams per cubic meter, and
C = a coefficient (0.0055 according to Hamon).

Hamon's equation requires only latitude, converted to day length (adjusted for slope and aspect), and mean temperature, converted to saturation vapor density, for computing monthly E_h.

Equation [1] predicts the "average" evapotranspiration. In the Colorado subalpine zone, this average is less than half the amount that could occur under conditions of unlimited energy supply, assumed herein as potential solar radiation. Accordingly, the coefficient C in equation [1] was empirically adjusted upward to obtain an expression for potential evapotranspiration under maximum solar input:

$$E_m = C'D^2P_t \qquad [2]$$

where C' is the adjusted coefficient. The daily potential evapotranspiration for each of 12 months as derived by equation [2] is supplied as a set of parameters for each hydrologic subunit.

To adjust maximum daily evapotranspiration for available energy, the values determined by equation [2] were modified according to the expression

$$E_s = \frac{SW}{P} E_m \qquad [3]$$

where
E_s = evapotranspiration adjusted for available energy in inches/day,
SW = the observed daily shortwave radiation in langleys,
P = potential shortwave radiation for the day as computed by Frank and Lee (1966).

In the water balance routines, the adjusted evapotranspiration as derived above is then redefined, depending on the source, as selected by the following sequence:

1. If snow is intercepted on the forest canopy, evaporation occurs exclusively from that source and is computed by subroutine CANVAP.

2. If the canopy is free of snow, the next step in the source selection is to determine if losses result from evapotranspiration (see subroutine EVTRAN) or evaporation from the snowpack surface (see subroutine SNOWVAP). If evaporation is from the snow surface or from intercepted snow, control then passes to the radiation balance routines. If a snowpack exists, the radiation routines generate any possible melt for input; otherwise, the only input that can result is from a rain event. Subroutine EVTRAN then calculates the evapotranspiration requirements, which are taken first from the input and, if not satisfied, from the soil mantle storage.

The various methods of computing evaporation and transpiration are discussed in the descriptions of the subroutines named above.

Once the evapotranspiration requirements have been satisfied, any remaining input, either from snowmelt or rainfall, is used to satisfy the soil mantle recharge requirements (see subroutine EVTRAN). When field capacity is reached, the excess input is considered to be water available for streamflow (generated runoff).

As explained later in this report, subroutine RADBAL includes a phase indicator that determines which of two methods is to be used to compute the effects of the radiation balance. When the seasonal snowpack is completely melted, the phase indicator is reset to the "accumulation phase." It remains at that setting until certain conditions specified in subroutine RADBAL are met; it then returns to the "melt phase" setting. Upon completion of the water balance calculations, WATBAL returns the results and the new values for the state variables to the calling routine. Here, they are weighted according to the percent of the total area occupied by the various hydrologic subunits. These weighted values are then summed to generate the watershed composite.

Subroutine CANVAP (fig. 3)

Hoover and Leaf (1967), Hoover (1969), and Hoover (in press),[2] have discussed the process and significance of interception loss in central Colorado subalpine forests. Field studies indicate that mechanical removal of intercepted snow by wind is an important phenomenon. Accordingly, wind effects were considered in the snow interception subroutine.

In developing this portion of the model, the following assumptions were made:

1. The amount of snow intercepted varies according to forest cover type and density;
2. The intercepted snow rests on the canopy for only 1 day following the day of the snow event because turbulent winds remove the snow from the crowns; and
3. The residual intercepted snow which is not vaporized after 1 day is added to the snowpack.

The amount of snow intercepted by spruce-fir was assumed to vary as

$$P_{if} = 0.15 \frac{C_d}{C_{dmx}} I_s \qquad [4]$$

where

P_{if} = water equivalent of intercepted snow in inches

I_s = water equivalent input which occurs as snow in inches,

C_{dmx} = natural forest cover density, expressed as a decimal, and

C_d = reduced forest cover density, as a decimal.

Interception in lodgepole pine is given by the equation

$$P_{ip} = 0.10 \frac{C_d}{C_{dmx}} I_s \qquad [5]$$

The assumed maximum amounts of snow interception are 0.2 and 0.3 inch for lodgepole pine and spruce-fir, respectively. Snowfall inputs which exceed the above values are added to the snowpack.

Vaporization of intercepted snow on foliage surfaces is assumed to vary as a function of forest cover density, C_d, and evapotranspiration is adjusted for available energy (equation 3) as follows:

$$V_c = \frac{1}{C_d} E_s \qquad [6]$$

where

V_c = intercepted snow evaporation in inches,

$C_d > 0$

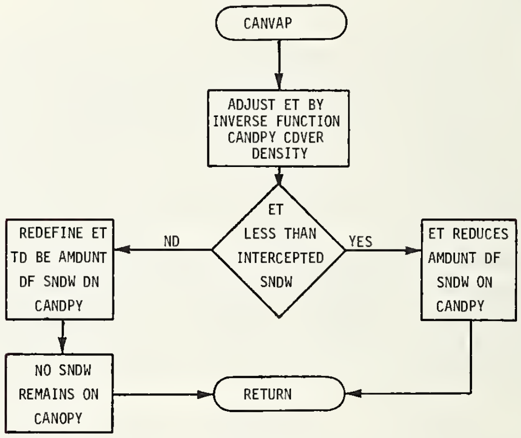


Figure 3. — Subroutine CANVAP.

If equation [6] yields a value which is less than the water equivalent of the intercepted snow, that water equivalent is merely reduced to satisfy the evaporation requirement, V_c. However, if equation [6] indicates a greater value than the intercepted water equivalent, V_c is reduced to the point where the requirement is satisfied by the water equivalent of the snow, which is completely vaporized from the canopy.

Subroutine SNOWVAP (fig. 4)

During conditions when the canopy is free of snow, that is, when time since the beginning of the last snowfall event is greater than 2 days, it is assumed that evaporation from the snowpack beneath the trees, V_s, takes place according to the relation

$$V_s = (1 - C_d) E_s \qquad [7]$$

when

C_d = 0(a forest opening),

$V_s = E_s$

[2] *Hoover, Marvin D. Snow interception and redistribution in the forest. Third Int. Seminar for Hydrol. Professors [Purdue Univ., Lafayette, Ind., July 1971] (in press).*

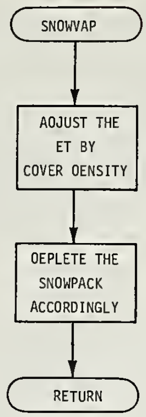


Figure 4. — Subroutine SNOWVAP.

Subroutine EVTRAN (fig. 5)

Available Soil Water Correction

There has been some work with crops and forest ecosystems to indicate that transpiration decreases as available water decreases (Denmead and Shaw 1962, Cowan 1965, Swanson 1967, Swanson 1969). Accordingly, equation [3] was further adjusted to account for available soil water. Denmead and Shaw (1962) point out that, in porous soils, the decline should not be pronounced until most of the "available water" is removed. Because subalpine soils are coarse textured (Retzer, 1962), it was assumed that transpiration of

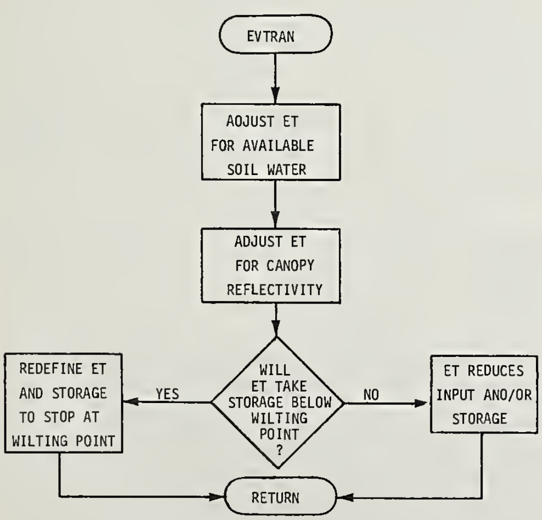


Figure 5. — Subroutine EVTRAN.

dense forest cover would proceed at rates given by equation [3] until the soil water is depleted to 50 percent of field capacity. Thereafter, transpiration is decreased in proportion to the amount of available soil water below one-half of field capacity. In open cutover areas, it was reasoned that the absence of dense vegetation would enable transpiration to proceed at rates given by equation [3] only when soil is at field capacity. In the model, it was assumed that the available soil water (mantle storage) is 5.3 inches in both the forest and open, based on an assumed average rooting depth of 4 feet, and a "wilting point" and "field capacity" of 4 percent and 15 percent by volume, respectively. Thus, equation [3] was expanded to obtain "actual" evapotranspiration in the forest, E_a, and in the open, E_{ao}, during the growing season as follows:

For Forest:

$$E_{af} = (1 - R_f)\ (0.377M)\ (E_s) \qquad [8]$$

For Open:

$$E_{ao} = (1 - R_f)\ (0.755M - 3)\ (E_s) \qquad [8a]$$

where

M = "available" mantle storage. When M exceeds 5.3 and 2.65 inches in the open and forest, respectively, evapotranspiration is computed by equation [3], and

R_f = reflectivity of the forest stand or open area as discussed below.

Radiation Balance and Evapotranspiration According to Forest Cover Density

Baumgartner (1967) and Tajchman (1971) have reported that evapotranspiration from coniferous forests is greater than from open land, although Tajchman reported smaller differences between forest and open land than did Baumgartner. Both Baumgartner and Tajchman discussed the differences in evapotranspiration from various cover types in terms of the differing energy balances. In presenting an analysis of the radiation balance and associated vapor loss, Baumgartner (1967) pointed out that "the only pertinent variations with regard to the latent heat flux are those associated with reflectivity . . . " Accordingly, a relationship

was derived between reflectivity and forest cover density (Leaf and Brink 1973) to index the reduction of evapotranspiration as forest cover is removed. For lack of any field data, the following tentative relationships were assumed:

$$R_f = 0.5 - \frac{0.75\ C_d}{C_{dmx}} \qquad [9]$$

where

R_f = the reflectivity of the forest stand,

C_{dmx} = natural forest cover density, expressed as a decimal, and

C_d = reduced forest cover density, as a decimal.

Equation [9] only applies when $C_d \leq \frac{C_{dmx}}{3}$.

When $C_d > \frac{C_{dmx}}{3}$, the reflectivity is given by

$$R_f = 0.25 - \frac{0.15}{0.67C_{dmx}} (C_d - 0.33C_{dmx}) \qquad [10]$$

The relationship given by equations [9] and [10] is plotted in figure 6. Note that when cover density $C_d = C_{dmx}$, $R_f = 0.1$, whereas when $C_d = 0$, $R_f = 0.5$. These values qualitatively agree with values given by Baumgartner (1967), who summarized variations of absorption coefficient for several cover types, and Burroughs (1971), who developed a shortwave reflectivity model for lodgepole pine forest which accounts for varying stand characteristics and season of the year.

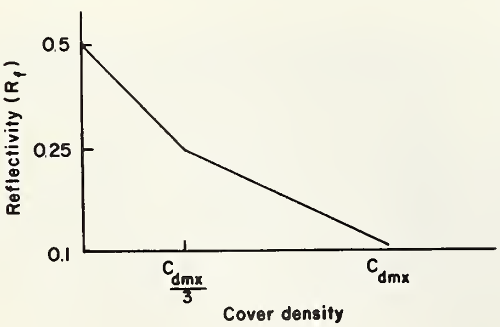


Figure 6. — Assumed variation of reflectivity (R_f) as a function of forest canopy density(C_d).

Seasonal Course of Transpiration

Swanson (1967) observed that transpiration can occur early in the snowmelt runoff season when there is still considerable snow cover. At the Fraser Experimental Forest, during the first week in May 1965, he observed a sharp upturn in sap flow when the snow cover still held an average of more than 5 inches of residual water equivalent. Accordingly, a threshold water equivalent was assumed in the model after which evapotranspiration is allowed to occur. This threshold is tentatively estimated to be 5 inches. Evapotranspiration is computed by equations [8] or [8a] above, and varies according to available energy, E_s, available mantle storage, M, and reflectivity, R_f, all of which have been discussed previously.

Once the evapotranspiration requirements have been established by the above adjustments, they are satisfied first from the input and then from the soil mantle storage. If the requirements would deplete storage below the wilting point, however, all values are adjusted to cause evapotranspiration to cease at that point.

During the winter, evapotranspiration is computed by equations [8] or [8a], provided the forest canopy is free of snow and the snowpack water equivalent is less than the critical 5 inches. When the snowpack exceeds 5 inches, only evaporation from intercepted snow and from the snow surface takes place.

Subroutine RADBAL (fig. 7)

This routine is essentially identical to the routine by the same name in the snowmelt model (Leaf and Brink 1973). The only changes necessary were to modify the calculations for year-round processing. Hence, the modification in RADBAL consists of a phase switch, which indicates optional methods of computing the radiation balance.

During the fall and winter before the diffusion model achieves mathematical stability (Leaf and Brink 1973), only shortwave radiation is used to compute snowmelt. Therefore, the only cold content in the snowpack results from newly fallen snow. (To insure snowpack accumulation during this phase, snowmelt is not "allowed" to take place on days when the mean air temperature is below 0° C.). Once the snowpack depth is sufficient for diffusion model stability (4.7 inches of water equivalent), the phase switch is reset to compute snowmelt according to the snowmelt simulation model (Leaf and Brink

1973). In other words, when the snowpack reaches the specified depth in the early winter, the switch is set to "melt when ready." The snowpack will continue to accumulate in this phase until the normal all-wave radiation balance produces snowmelt. The switch is reset to the snow accumulation phase at the end of the snowmelt season (when snowpack water equivalent is zero).

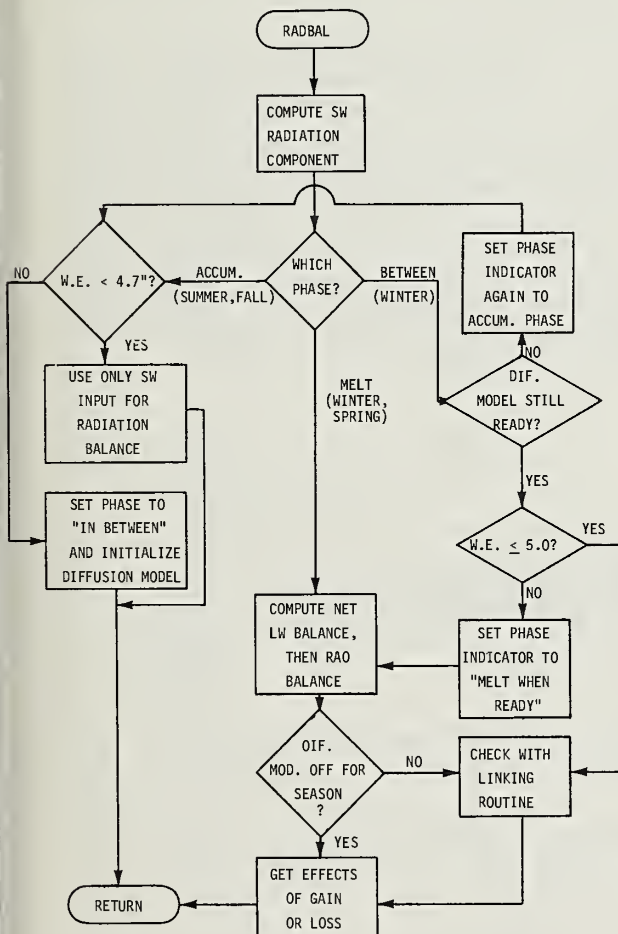


Figure 7. — Subroutine RADBAL.

Subroutine SNOWED (fig. 8)

The only difference between this routine and its counterpart in the snowmelt model (Leaf and Brink 1973) is the inclusion of interception calculations. The amount of snow intercepted on a given day is computed as a percentage, which is determined by the

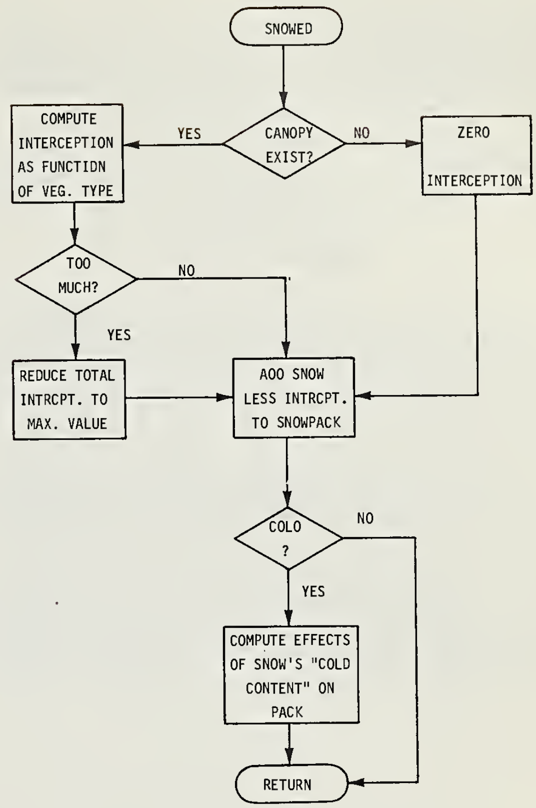


Figure 8. — Subroutine SNOWED.

vegetation type as discussed in subroutine CANVAP. The total amount which may remain on the canopy after several consecutive snow events is also determined by vegetation type.

Peripheral Routines

The peripheral routines are not flowcharted or discussed in detail on an individual basis, since they are primarily utility routines for input, output, and maintenance of continuity between simulation intervals. Subroutines GENDATA, RADCOMP, and RDMSTR are all concerned with input, and use various analyses to generate the daily input for each substation from observed base station data. Subroutines ETCODE and PLOTTER are output routines which aid in the interpretation of results.

All of the above routines are utilized on each run of the model, but to save time and core, most output options are included as overlays, only one of which is selected at a

time to occupy core and process the data. Each overlay consists of a control routine, a normal simulation routine, a write routine, and any watershed management alternative simulation routines that may be needed.

A complete listing of the model described in this report is included in the appendix.

Applications

We have used the hydrologic model to simulate area snowmelt and water yield from the 667-acre Deadhorse Creek watershed at the Fraser Experimental Forest (Leaf 1971; Leaf and Brink 1972, 1973). Physical characteristics of this watershed vary from low-elevation (9,300 ft. m.s.l.) south slopes in lodgepole pine forest to high-elevation (11,000 ft.) north slopes in spruce-fir. Simulations from 10 subunits on the basin were weighted according to the percentage of the total area each represents to generate the watershed composite. Each subunit was selected according to forest cover type and density, slope, aspect, and average elevation. Simulations of the 1963-70 water years (October 1 to September 30) indicate to us that the model represents the inherent hydrologic characteristics of Colorado subalpine watersheds. Sample output in the form of 10-day summations for the 1967 water year is shown in table 1. Figure 9 summarizes 10-day fluctuations of several hydrologic variables for the 1965 water year. Figure 10 compares simulated and observed annual water yields from Deadhorse Creek for the 1964-71 record period.

We have predicted the change in rate and seasonal time distribution of snowmelt resulting from clearcutting small openings in old-growth forest with the snowmelt portion of the model (Leaf and Brink 1972). With the increased water balance simulation capability, we plan to develop the model into a useful tool for predicting the hydrologic consequences of several resource management practices. In the Colorado subalpine zone, these include weather modification and timber harvesting.

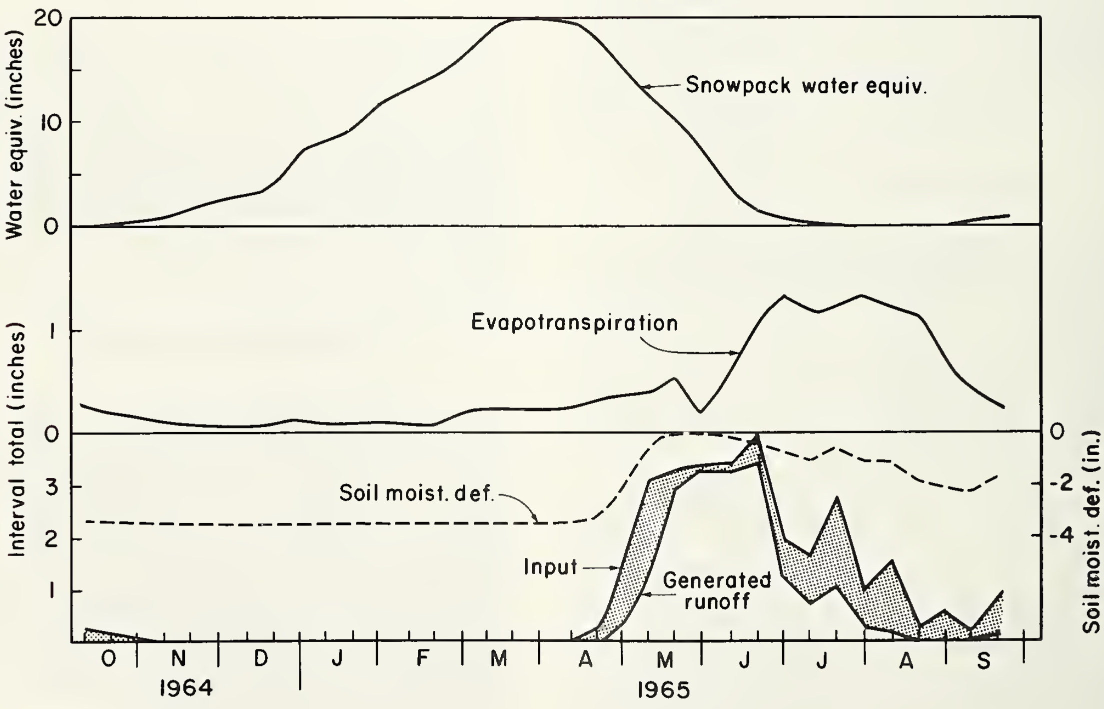


Figure 9. — Simulated 10-day fluctuations of several hydrologic components during the 1965 water year on Deadhorse Creek, Fraser Experimental Forest.

Table 1.--Water balance simulation, 1967 water year

Fraser Experimental Forest, Deadhorse Creek - 667 acres — Composite of 10 substations

Date	Current		Interval totals				Year to date				
	Snowpack water equivalent	Recharge requirement	Precipitation	Input	Evapotranspiration from--[1]	Generated runoff	Precipitation	Input	Evapotranspiration	Generated runoff	Change in recharge requirement
	Inches										
10 10 66	0.16	-2.84	0.86	0.62	0.3498 C E	0.05	0.86	0.62	0.3498	0.05	0.29
10 20 66	.46	-2.60	.85	.47	.2687	.04	1.70	1.09	.6186	.09	.54
10 30 66	.34	-2.80	.00	.12	.3168 E	.00	1.70	1.21	.9354	.09	.34
11 10 66	1.43	-2.80	1.25	.08	.1571 C E	.00	2.95	1.30	1.0925	.09	.34
11 20 66	1.45	-2.85	.06	.04	.0959 C E	.00	3.01	1.33	1.1884	.09	.28
11 30 66	1.75	-2.87	.39	.05	.0971 C E	.00	3.40	1.38	1.2855	.09	.27
12 10 66	3.69	-2.87	2.04	.01	.1017 CSE	.00	5.44	1.39	1.3872	.09	.26
12 20 66	3.73	-2.90	.05	.00	.0333 CSE	.00	5.48	1.39	1.4205	.09	.23
12 30 66	3.87	-2.93	.15	.00	.0404 CSE	.00	5.63	1.39	1.4610	.09	.21
1 10 67	4.92	-2.93	1.14	.00	.1000 CSE	.00	6.77	1.39	1.5610	.09	.20
1 20 67	6.43	-2.94	1.64	.00	.1223 CSE	.00	8.41	1.39	1.6833	.09	.20
1 30 67	7.16	-2.92	.83	.02	.0907 CSE	.00	9.24	1.41	1.7740	.09	.21
2 10 67	8.49	-2.93	1.46	.00	.1179 CSE	.00	10.70	1.41	1.8920	.09	.21
2 20 67	10.69	-2.93	2.36	.00	.1788 CS	.00	13.06	1.41	2.0708	.09	.21
3 10 67	11.90	-2.93	1.49	.00	.2775 CS	.00	14.55	1.41	2.3483	.09	.21
3 20 67	13.20	-2.88	1.61	.05	.2612 CS	.00	16.16	1.46	2.6095	.09	.25
3 30 67	13.31	-2.68	.48	.20	.1762 CS	.00	16.64	1.66	2.7857	.09	.45
4 10 67	12.92	-2.43	.35	.42	.3183 CS	.16	16.99	2.08	3.1039	.26	.71
4 20 67	12.69	-1.87	.93	.87	.3418 CSE	.26	17.92	2.95	3.4457	.52	1.26
4 30 67	12.35	-1.45	.78	.89	.2632 CSE	.43	18.70	3.85	3.7089	.95	1.68
5 10 67	11.63	-1.35	.57	.94	.4397 CSE	.75	19.27	4.78	4.1487	1.70	1.78
5 20 67	9.49	- .58	.57	2.42	.3761 CSE	1.55	19.83	7.20	4.5247	3.26	2.56
5 30 67	6.04	- .07	.38	3.51	.5529 CSE	2.78	20.21	10.71	5.0777	6.03	3.06
6 10 67	2.83	- .27	.47	3.36	.9556 CSE	2.92	20.68	14.07	6.0333	8.96	2.86
6 20 67	1.47	- .05	1.58	2.85	.4260 CSE	2.29	22.26	16.92	6.4593	11.25	3.09
6 30 67	.68	- .54	.82	1.56	1.1143 CSE	.98	23.08	18.48	7.5736	12.23	2.59
7 10 67	.00	-1.34	.58	1.24	1.3991 SE	.66	23.66	19.71	8.9727	12.88	1.80
7 20 67	.00	-2.46	.40	.40	1.5228 E	.00	24.06	20.11	10.4955	12.88	.68
7 30 67	.00	-3.12	.58	.58	1.2406 E	.00	24.63	20.69	11.7362	12.88	.01
8 10 67	.00	-2.83	1.13	1.13	.8239 E	.02	25.76	21.82	12.5601	12.90	.30
8 20 67	.00	-3.58	.12	.12	.8617 E	.00	25.88	21.94	13.4218	12.90	- .44
8 30 67	.00	-3.95	.17	.17	.5433 E	.00	26.05	22.11	13.9651	12.90	- .81
9 10 67	.00	-4.17	.11	.11	.3346 E	.00	26.16	22.22	14.2997	12.90	-1.04
9 20 67	.00	-3.04	1.53	1.46	.3502 C E	.04	27.69	23.68	14.6499	12.94	.10
9 30 67	.00	-3.17	.47	.46	.5844 C E	.02	28.16	24.14	15.2343	12.96	.04

[1] C = interception loss
S = Evaporation from snowpack
E = Evapotranspiration

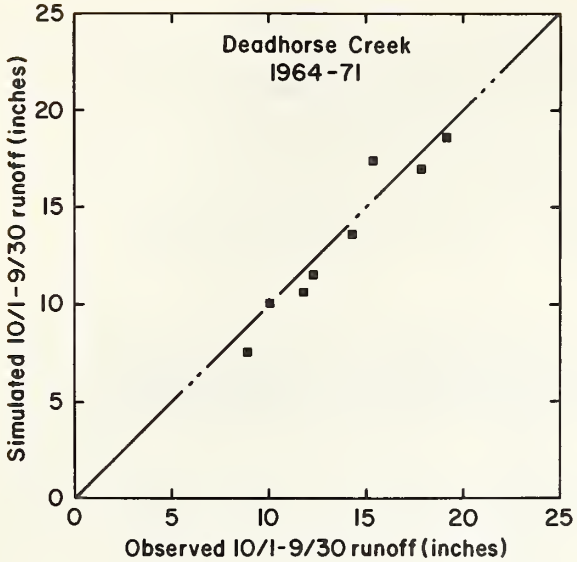


Figure 10. — Simulated versus observed annual runoff on Deadhorse Creek, 1964-71.

Literature Cited

Baumgartner, A.
1967. Energetic bases for differential vaporization from forest and agricultural lands. p. 381-389. **In** Forest Hydrology. W. E. Sopper and H. W. Lull, eds. [Int. Symp. For. Hydrol., Univ. Park, Pa., Aug.-Sept. 1965]. 813 p. N.Y.: Pergamon Press.

Bouchet, R. J.
1963. Evapotranspiration reelle et potentielle signification climatique. Int. Assoc. Sci. Hydrol. Publ. 62, p. 134-142.

Burroughs, Edward R., Jr.
1971. Short-wave reflectivity model of a lodgepole pine. 107 p. Ph.D. dissertation, Colo. State Univ., Fort Collins. (Diss. Abstr. 32:2834-35 B, 1971).

Cowan, I. R.
1965. Transport of water in the soil-plant-atmosphere system. J. Appl. Ecol. 2: 221-239.

Denmead, O. T., and R. H. Shaw.
1962. Availability of soil water to plants as affected by soil moisture content and meteorological conditions. Agron. J. 54: 385-389.

Frank, Ernest C., and Richard Lee.
1966. Potential solar beam irradiation on slopes. Tables for 30° to 50° latitude. U.S. For. Serv. Res. Pap. RM-18, 116 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Hamon, W. R.
1961. Estimating potential evapotranspiration. Am. Soc. Civil Eng., J. Hydraul. Div., 87(HY3): 107-120.

Hoover, M. D.
1969. Vegetation management for water yield. Symp. on Water Balance in North America [Banff, Alberta, Canada, 1969] Proc. Ser. 7, p. 191-195. Am. Water Resour. Assoc., Urbana, Ill.

Hoover, Marvin D., and Charles F. Leaf.
1967. Process and significance of interception in Colorado subalpine forest. p. 213-223. **In** Forest Hydrology. W. E. Sopper and H. W. Lull, eds. [Int. Symp. For. Hydrol., Univ. Park, Pa., Aug.-Sept. 1965]. 813 p. N.Y.: Pergamon Press.

Leaf, Charles F.
1971. Areal snow cover and disposition of snowmelt runoff in Central Colorado. USDA For. Serv. Res. Pap. RM-66, 19p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Leaf, Charles F., and Glen E. Brink.
1972. Simulating effects of harvest cutting on snowmelt in Colorado subalpine forest. p. 191-196. **In** Watersheds in Transition Symp. [Fort Collins, Colo., June 1972] Proc. Ser. 14, 405 p. Am. Water Resour. Assoc., Urbana, Ill.

Leaf, Charles F., and Glen E. Brink.
1973. Computer simulation of snowmelt within a Colorado subalpine watershed. USDA For. Serv. Res. Pap. RM-99, 22 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Morton, F.I.
1971. Catchment evaporation and potential evaporation further development of a climatological relationship. J. Hydrol. 12: 81-99.

Retzer, J. L.
1962. Soil survey, Fraser alpine area, Colorado. U.S. Dep. Agric. For. Serv. and Soil Conserv. in coop. with Colo. Agric. Exp. Stn. Ser. 1956, No. 20, 47 p.

Russell, R. L., and W. R. Boggess.
1964. Evaluation of the Hamon method of determining potential evapotranspiration. Univ. Ill. Agric. Exp. Stn., Dep. For. Note 108, 4 p.

Stephens, John C., and Ernest H. Stewart.
1963. A comparison of procedures for computing evaporation and evapotranspiration. Int. Assoc. Sci. Hydrol. Publ. 62, p. 123-133.

Swanson, Robert H.
1967. Seasonal course of transpiration of lodgepole pine and Engelmann spruce. p. 419-433. **In** Forest Hydrology. W. E. Sopper and H. W. Lull, eds. [Int. Symp. For. Hydrol., Univ. Park, Pa., Aug.-Sept. 1965]. 813 p. N.Y.: Pergamon Press.

Swanson, Robert H.
1969. The tree as a dynamic system in forest-water resource research. For. Microclimate Symp. [Kananaskis For. Exp. Stn., Seeke, Alberta] Proc. 3: 34-39.

Tajchman, S. J.
1971. Evapotranspiration and energy balances of forest and field. Water Resour. Res. 7: 511-523.

Takhar, H. S., and A. J. Rudge.
1970. Evaporation studies in standard catchments. J. Hydrol. 11: 329-362.

Appendix I: Routines for Water Balance Model

Program WBMODEL

```
      DVERLAY (OLAYS,D,0)
      PRDGRAM WBMDDEL (INPUT,DUTPUT,PLDTS,TAPE5=INPUT,TAPE6=DUTPUT,
     1 TAPE11=PLDTS)
C-----THIS IS THE CDNTRDLLING RDUTINE FDR THE WATER BALANCE MDDEL.  THE
C----- MDDEL IS OVERLAYED TD SAVE TIME AND MEMORY. THE CDRE DF THE MDDEL
C----- IS SUBRDUTINE WATBAL AND ITS RELATED ROUTINES. ALL DF THESE, PLUS
C----- SEVERAL I/O RDUTINES WHICH HAVE NO DPTIDNS, ARE INCLUDED IN THIS
C----- MAIN DVERLAY SO THEY ARE AVAILABLE TD THE DVERLAYS WHICH ARE
C----- SELECTED BY DPTIDN.  THE FIRST DVERLAY LDADED ESTABLISHES THE
C----- WATERSHED DESCRIPTDRS AND PARAMETERS AND INDICATES THE DVERLAYS
C----- TO BE SELECTED ACCDRDING TD THE DUTPUT DPTIDNS.  THE NEXT DVERLAY
C----- TD BE LDADED WILL CDNTAIN THE DUTPUT RDUTINE SELECTED AND ITS
C----- NDRMAL SIMULATIDN RDUTINE.  IT WILL THEN LDAD DNE DF ITS
C----- SECDNDARY OVERLAYS WHICH WILL CDNTAIN THE MAIN DPERATING PRDGRAM
C----- FDR THIS RUN AND ANY ALTERNATIVES THAT ARE TD BE INCLUDED.
C-----
C-----THE CDRE DF THE MDDEL (SUBRDUTINE WATBAL, ET AL) IS DESIGNED TD
C----- FUNCTIDN AS AN INDEPENDENT UNIT, TOTALLY UNCDNCERNED WITH I/D AND
C----- MAINTENANCE  DF CDNTINUDUS DR STATIC CONDITIDNS.  THE DNLY LINKS
C----- WITH THE DPERATING PRDGRAM, ITS ALTERNATIVES AND I/D RDUTINES,
C----- ARE THE FDRMAL PARAMETERS AND CDMMDN BLDCK /WATRBAL/.  EACH
C----- RDUTINE WHICH UTILIZES THE CORE MUST MAINTAIN ITS DWN SET DF
C----- CONTINUDUS CDNDITIONS AND MAKE THEM AVAILABLE AT THE PRDPER TIME
C----- FOR USE BY THE CDRE.  THE BLANK CDMMDN AND LABELLED CDMMDN BLDCKS
C----- ESTABLISHED HERE IN THE MAIN DVERLAY ARE PRIMARILY FDR THE USE DF
C----- THE NDRMAL SIMULATIDN RDUTINE.  THEREFDRE, SIMILAR LDCATIDNS MUST
C----- BE SET ASIDE FDR MAINTENANCE  BY ANY AND ALL ALTERNATIVES.
      CDMMON AIRTEMC(25,6)
      CDMMDN CALDEF(25),CDMAX(25),CDVDEN(25)
      CDMMDN DREADY(25)
      CDMMDN ENGBAL(25),ET,ETDAILY(25,12)
      CDMMDN FREEWAT(25)
      CDMMON ISOTHRM(25,20)
      CDMMDN LASTUSD(25),LEVEL1,LEVEL2
      CDMMDN MMDD
      CDMMDN NDAYSND(25),NDIVSBL,NSUB,NYEARS
      CDMMDN DNTREES(25)
      CDMMDN PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),PDTENT(24),
     1  .    PREWEQV(25)
      CDMMDN RECHRG(25)
      CDMMDN SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      CDMMDN TCOEFF(25),THRSHLD(25),TDPLDT(11)
      CDMMDN VEGTYPE(25)
      CDMMDN WEIGHT(25),WSHEDID(6)
      CDMMDN YEARS(20),YYMMOD
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEDIO
      INTEGER YEARS,YYMMDD
      CDMMDN/CMPSITO/CDMPS(16),YRTDT(5)
      CDMMDN/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTDNDW,DBSHYDR,
     I PDTRAO,MSTREOF,IYR
      INTEGER DATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      DATA COMPS,YRTOT/21*0.D/
      DATA IYR,MSTREOF/1,D/
      CALL DVERLAY (5HOLAYS,1,0)
      CALL DVERLAY (5HOLAYS,LEVEL1,D)
C-----FILE -PLOTS- IS COPIED TO -OUTPUT- BY A STANDARD MDNITOR COPY
      END
```

Subroutine WATBAL

```
      SUBRDUTINE WATBAL (F1,F2,F3,I1,F4,F5,I2,I3,F6,I4,F7,FB,F9,F10,F11,
     1 F12,F13,I5)
C-----THIS SUBROUTINE IS THE MAIN ROUTINE OF THE WATER BALANCE MDDEL. IT
C----- RECEIVES THE DRIVING, STATIC AND CONTINUOUS VARIABLES FROM THE
C----- OPERATING ROUTINES, CONTRDLS THE COMPUTATIONS ON THEM, AND
C----- RETURNS THE NEW VALUES FOR THE CONTINUOUS VARIABLES AND THE
C----- RESULTS OF THIS INTERVAL.  SEE THE REPLACEMENT STATEMENTS BELOW
C----- FOR THE VARIABLE DEFINITIONS OF THE PARAMETERS
C
C-----DICTIONARY OF WATER BALANCE COMMON BLOCKS
C
C     AVETEMC - THE MEAN TEMPERATURE FOR THE INTERVAL IN DEGREES C
C     BASTEMF - BASE TEMPERATURE DEGREES FARENHEIT, RAIN TURNS TD SNDW
C     CALDEF - THE CALORIE DEFICIT IS THE NUMBER OF CALORIES NEEDED
C                 TO BRING THE SNOWPACK TEMPERATURE TO ZERO DEGREES
C                 CENTIGRADE (NOTE SHOULD BE MADE THAT IT IS A POSITIVE
C                 QUANTITY)
C     CDVDEN - THE CDVER DENSITY IS THE FRACTION OF THE GROUND OR SNDW
C                 SURFACE SHADED FROM DIRECT SUNLIGHT OR RADIATION
C     DREADY = D, DIFFUSION MODEL (SUBROUTINE DIFMOD) NOT INITIALIZED
C            = 1, DIFFUSION MODEL INITIALIZED AND READY FOR SNOWPACK
C                 TEMPERATURE SIMULATION
C            = -1, DIFFUSION MODEL MAY NDT BE USED
C     ENGBAL - THE TOTAL CALORIC INPUT TO OR LOSS FROM THE SNOWPACK
C                 DURING AN INTERVAL.  IT IS THE ALGEBRAIC SUM DF THE
C                 ENERGY INVOLVED WITH THE PRECIPITATION AND THAT OF
C                 THE RADIATION BALANCE
C     ENGBAL1 - THE VALUE OF -ENGBAL- AT THE END OF THE LAST INTERVAL
C     ETFROM = 1, EVAPORATIDN IS FROM THE CANOPY
C            = 2, EVAPORATION IS FROM THE SURFACE OF THE SNOWPACK
C            = 4, EVAPOTRANSPIRATIDN IS FROM SNOWMELT, RAIN DR THE
C                 SOIL MANTLE STORAGE
C     EVAPDTR - WHEN FIRST RECEIVED, THIS VARIABLE IS THE POTENTIAL
C                 EVAPOTRANSPIRATIDN AS CDMPUTED BY THE HAMDN METHOD
C                 AND ADJUSTED FDR AVAILABLE RADIATIDN.  AFTER ACTION
C                 IS TAKEN BY THE WATER BALANCE RDUTINES, THE ORIGINAL
C                 VALUE HAS BEEN ADJUSTED FURTHER BY THE METHDDS
C                 DISCUSSED IN SUBRDUTINES CANVAP, EVTRAN, AND SNDWVAP.
C                 IT THEN REPRESENTS THE EVAPDTRANSPIRATIDN DURING THIS
C                 INTERVAL
C     FREEWAT - THE FREE WATER BEING HELD BY THE SNDWPACK
C     LASTUSD - AN INDICATOR USED IN FUNCTIDN PACKREF TO DETERMINE
C                 WHICH REFLECTIVITY FUNCTIDN TO USE
C     NDAYSND - THE NUMBER DF DAYS SINCE NEW SNOW HAS FALLEN
C     ONTREES - THE VDLUME DF INTERCEPTED SNOW REMAINING DN THE CANDPY
C     PHASE = -1, THE SNDWPACK HAS BARELY ACCUMULATED TD THE PDINT WHERE
C                 THE DIFFUSIDN MDDEL IS STABLE AND MAY BE USED TD
C                 CDNTRDL THE SNOWPACK TEMPERATURE
C           = 0, THE SNOWPACK IS ACCUMULATING AND HAS NOT YET REACHED
C                 A DEPTH WHICH WILL PROVIDE STABILITY FOR THE
C                 DIFFUSIDN MDDEL
C           = 1, THE SNDWPACK HAS REACHED A SUFFICIENT DEPTH TD ALLDW
C                 THE DIFFUSION MDDEL TD CDNTRDL THE PACK TEMPERATURE
C                 UNTIL THE MELT SEASDN, WHEN THE RADIATIDN RDUTINES
C                 RESUME CDNTRDL TD GDVERN THE MELT PHASE
C     PRECIP - DBSERVED PRECIPITATIDN IN INCHES
C     PREWEQV - PREDICTED WATER EQUIVALENT DF THE SNDWPACK IN INCHES
C     RADIN - RADIATION IN IS THE TOTAL INCIDENT SHORT WAVE RADIATIDN
C     RADLWN - NET LDNG WAVE RADIATIDN IS THE ALGEBRAIC SUM DF THE LDNG
C                 WAVE RADIATION FRDM THE FDREST AND THE LDNG WAVE
C                 RADIATIDN LDST BY THE SNDWPACK TO THE CANDPY
C     RADSWN - THE CALORIC INPUT TO THE PACK BY THE NET SHDRT WAVE
C                 RADIATION
C     RECHRG - THE RECHARGE REQUIREMENTS, DR SDIL MANTLE STDRAGE DEFICIT
C     SIMTEM1 - AN ARRAY USED PRIMARILY IN SUBRDUTINE DIFMDD IN THE
C                 SIMULATIDN DF THE AVERAGE SNOWPACK TEMPERATURE.
C                 TD INSURE STABILITY OF THE DIFFUSIDN MDDEL, THE
C                 DAY IS PARTITIDNED INTD 12 HDUR INTERVALS, AS
C                 DISCUSSED IN SUBRDUTINE DIFMOD.  THIS ARRAY STDRES
C                 THE CONDITIDNS PRESENT DURING THIS INTERVAL FDR USE
C                 IN THE SIMULATIDN DN THE NEXT INTERVAL.  LDCATIDN 1
C                 STDRES THE AVERAGE AIR TEMPERATURE (ASSUMED TD BE
C                 THE SURFACE TEMPERATURE DF THE SNDWPACK), LDCATIDN 2
C                 IS THE SNDWPACK TEMPERATURE AT A NDDE MIDWAY
C                 BETWEEN THE SURFACE AND THE GRDUND, AND LDCATIDN 3 IS
C                 THE GRDUND TEMPERATURE.
C     TCDEFF - THE TRANSMISIVITY CDEFFICIENT USED TD ESTIMATE THE NET
C                 SHDRT WAVE RADIATIDN REACHING THE SNDWPACK.  SEE
C                 REIFSNYDER AND LULL, RADIANT ENERGY IN RELATIDN TD
C                 FDRESTS, USFS TECH. BUL 1344, 1965.
C     TEMPMAX - THE MAXIMUM TEMPERATURE DURING THE INTERVAL IN DEGREES
C                 FARENHEIT
C     TEMPMIN - THE MINIMUM TEMPERATURE DURING THE INTERVAL IN DEGREES
C                 FARENHEIT
C     THRSHLD - THE THRESHDLD TEMPERATURE FDR DETERMINING WHETHER OR NDT
C                 TO RE-INITIALIZE THE REFLECTIVITY FUNCTIDN WHEN
C                 THERE IS A SNOW EVENT.  IF THE MAXIMUM TEMPERATURE IS
C                 GREATER THAN THE THRESHDLD VALUE DD NDT RE-INITIALIZE
C                 THE FUNCTIDN REGARDLESS OF THE PRECIPITATION
C     WATERIN - THE SUM OF ANY SNOWMELT AND ANY RAIN WHICH PROVIDES
C                 DIRECT INPUT TO THE WATER BALANCE
C
      COMMDN/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,CDMAX,COVDEN,DREADY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREADY,PHASE,VEGTYPE
      CDMMON/WATRBAL/ETFROM,EVAPDTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     I TEMPMAX,TEMPMIN,WATERIN
      DATA AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,DREADY,ENGBAL,ENGBAL1,
     1 FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,SIMTEM1,
     2 SIMTEM3,TCDEFF,THRSHLD,VEGTYPE/0.0,35.0,3*0.0,0,2*-1.0,D.D,2*0,
     3 D.0,D,6*0.D,1.0,0.0,1/
C-----OBTAIN THE STATIDN DESCRIPTORS
      CDVDEN = F3
      CDMAX = F2
      TCDEFF = F12
      VEGTYPE = I5
C-----RECALL THE CONTINUOUS VARIABLES NECESSARY FOR THE OPERATIDN OF THE
C----- MODEL DURING THIS INTERVAL
      CALDEF = F1
      DREADY = I1
      ENGBAL1 = F4
      FREEWAT = F5
      LASTUSD = I2
      NDAYSNO = I3 + I
      DNTREES = F6
      PHASE = I4
      PREWEQV = F7
      RECHRG = FB
      THRSHLD = F13

      IF(DREADY) 20,2D,1D
   10 SIMTEM1(1) = F9
      SIMTEMI(2) = F1D
      SIMTEM1(3) = F11
C-----AVETEMC = (((TEMPMAX-32)+(TEMPMIN-32))/2)*(5/9)
   20 AVETEMC = (TEMPMAX + TEMPMIN - 64.0) * 0.277777777B
C-----START THE ENERGY BALANCE AND THE INPUT AT ZERO FOR THIS INTERVAL
      ENGBAL = 0.0
      WATERIN = 0.0
C-----IF THERE IS NO PRECIP, THERE IS NO NEED TO PASS THROUGH THE
C----- CLASSIFICATION STATEMENTS
      IF(PRECIP) 90,90,3D
C-----SEE IF THE PRFCIP IS ALL SNOW
```

```
   30 IF(TEMPMIN.LE.32.0.OR.TEMPMAX.LT.BASTEMF) GO TO 80
C-----SEE IF ANY OF IT IS SNOW
      IF(TEMPMIN - BASTEMF) 40,50,50
   40 CALL MIXTURE
      GO TO 90
C-----THIS IS A RAIN EVENT.  IF THERE IS NO PACK, THE RAIN IS DIRECT
C----- INPUT TO THE WATER BALANCE.  BUT IF THERE IS A PACK, DETERMINE
C----- THE EFFECTS OF THE RAIN
   50 IF(PREWEQV) 60,60,70
   60 WATERIN = PRECIP
      GO TO 160
   70 CALL RAINED (AVETEMC,PRECIP)
      GO TO 90
C-----THIS IS A SNOW EVENT
   80 CALL SNOWED (AMIN1 (AVETEMC,0.0),PRECIP)
C-----IF THERE IS SNOW ON THE TREES, EVAPORATE ONLY FROM THE CANOPY
   90 IF(ONTREES) 130,130,100
  100 CALL CANVAP
C-----ON THE FIRST DAY AFTER FRESH SNOW, ASSUME TURBULENCE HAS REMOVED
C----- ANY REMAINING INTERCEPTED SNOW AND ADDED IT TO THE PACK
      IF(NDAYSNO - 1) 120,110,110
  110 PREWEQV = PREWEQV + ONTREES
      ONTREES = 0.0
C-----IF THERE IS NO SNOWPACK, BYPASS THE RADIATION ROUTINES
  120 IF(PREWEQV) 190,190,180
C-----DETERMINE WHETHER TO SATISFY THE EVAPOTRANSPIRATION REQUIREMENTS
C----- UNDER GROWING SEASON OR WINTER CONDITIONS
  130 IF(PREWEQV) 160,160,140
  140 IF(PREWEQV - 5.0) 150,150,170
C-----USE THE GROWING SEASON ROUTINES TO INCLUDE TRANSPIRATION
  150 CALL RADBAL
C-----ADD -WATERIN- TO THE RECHARGE REQUIREMENTS SO THE ET ROUTINE CAN
C----- OPERATE ON THE INPUT AS WELL AS THE STORAGE
  160 RECHRG = RECHRG + WATERIN
      CALL EVTRAN
      GO TO 200
C-----USE THE WINTER ROUTINES TO EVAPORATE FROM THE SNOWPACK SURFACE
  170 CALL SNOWVAP
  180 CALL RADBAL
C-----ADD -WATERIN- TO THE RECHARGE REQUIREMENTS
  190 RECHRG = RECHRG + WATERIN
C-----IF THE RECHARGE REQUIREMENTS WERE SATISFIED, THE EXCESS IS
C----- CONSIDERED TO BE GENERATED RUNOFF
  200 IF(RECHRG) 220,220,210
  210 GENRO = RECHRG
      F8 = 0.0
      GO TO 230
  220 GENRO = 0.0
      F8 = RECHRG
  230 I1 = DREADY
      F1 = CALDEF
      F4 = ENGBAL
      F5 = FREEWAT
      I2 = LASTUSD
      I3 = NDAYSNO
      F6 = ONTREES
      F7 = PREWEQV
C-----WHEN THE PACK IS GONE, RESET THE PHASE INDICATOR
      IF(PREWEQV) 240,240,250
  240 I4 = 0
      RETURN
  250 I4 = PHASE
      IF(DREADY) 270,270,260
  260 F9 = SIMTEM1(1)
      F10 = SIMTEM1(2)
      F11 = SIMTEM1(3)
  270 RETURN
      END
```

Subroutine CALIN

```
      SUBROUTINE CALIN (CALORIN)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF THE CALORIC INPUT ON THE
C----- SNOWPACK
C     HOLDCAP - THE FREE WATER HOLDING CAPACITY OF THE SNOWPACK
C               (ASSUMED TO BE FOUR PERCENT OF THE WATER EQUIVALENT)
C-----
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,DREADY,ENGBAL
     1 ENGBAL1,FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREADY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----ADD THESE CALORIES INTO THE ENERGY BALANCE
      ENGBAL = ENGBAL + CALORIN
C-----SEE IF A CALORIE DEFICIT EXISTS IN THE PACK
      COMPARE = CALORIN - CALDEF
      IF(COMPARE) 10,20,30
C-----THERE IS A CALORIE DEFICIT, BUT THE INPUT DID NOT COMPLETELY
C----- WIPE IT OUT.  ALL OTHER CONDITIONS ARE UNCHANGED
   10 CALDEF = - COMPARE
      RETURN
C-----THE CALORIE DEFICIT WAS WIPED OUT, BUT ALL OTHER CONDITIONS ARE
C----- UNCHANGED
   20 CALDEF = 0.0
      RETURN
C-----ANY DEFICIT WHICH DID EXIST WAS WIPED OUT.  COMPUTE THE POTENTIAL
C----- MELT FROM THE REMAINING CALORIES (CALORIES/(80.0 * 2.54))
   30 POTMELT = COMPARE/203.2
      CALDEF = 0.0
C-----IF THE INPUT WAS ENOUGH TO MELT THE WHOLE PACK, CONTRIBUTE THE
C----- WATER EQUIVALENT TO THE SNOWMELT AND ZERO ALL CONDITIONS
      IF(POTMELT.LT.PREWEQV-FREEWAT) GO TO 40
      WATERIN = WATERIN + PREWEQV
      PREWEQV = 0.0
      FREEWAT = 0.0
      RETURN
C-----DEPLETE THE ICE PACK BY THE AMOUNT MELTED AND CONTRIBUTE THAT
C----- AMOUNT TO THE FREE WATER
   40 FREEWAT = FREEWAT + POTMELT
C-----COMPUTE THE NEW HOLDING CAPACITY OF THE PACK AND COMPARE IT WITH
C----- THE FREE WATER TO SEE IF SNOWMELT IS PRODUCED
      HOLDCAP = 0.04 * (PREWEQV - FREEWAT)
      COMPARE = FREEWAT - HOLDCAP
      IF(COMPARE.LE.0.0) RETURN
C-----THE SNOWMELT CONTRIBUTED IS IN -COMPARE-.  REDUCE THE FREE WATER
C----- TO LEAVE A PRIMED PACK AND REDUCE THE PREDICTED WATER EQUIVALENT
      PREWEQV = PREWEQV - COMPARE
      WATERIN = WATERIN + COMPARE
      FREEWAT = HOLDCAP
      RETURN
      END
```

Subroutine CALOSS

```
      SUBROUTINE CALOSS (CALOUT)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF THE CALORIC LOSS ON THE
C----- SNOWPACK
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,DREADY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREADY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----ADD ALGEBRAICALLY THESE CALORIES INTO THE ENERGY BALANCE
      ENGBAL = ENGBAL + CALOUT
C-----SEE IF THERE IS ANY FREE WATER IN THE PACK.  IF NOT, THE LOSS IS
C----- JUST CONTRIBUTED TO THE CALORIC DEFICIT OF THE SNOWPACK.
C----- REMEMBER THAT -CALOUT- IS NEGATIVE
      IF(FREEWAT.GT.0.0) GO TO 10
      CALDEF = CALDEF - CALOUT
      RETURN
C-----COMPUTE THE CALORIC LOSS NECESSARY TO FREEZE ALL OF THE FREE WATER
C----- (FREE WATER * 80.0 * 2.54)
   10 CALNEED = FREEWAT * 203.2
C-----NOW COMPARE THAT NECESSARY LOSS WITH THE ACTUAL LOSS.  IF THEY ARE
C----- THE SAME, THE FREE WATER IS WIPED OUT BUT NO OTHER CONDITIONS ARE
C----- ALTERED
      COMPARE = CALOUT + CALNEED
      IF(COMPARE) 20,30,40
C-----THE LOSS WAS MORE THAN ENOUGH TO FREEZE IT.  THE BALANCE CREATES
C----- AN ENERGY DEFICIT IN THE PACK AND THE FREE WATER IS WIPED OUT
   20 CALDEF = - COMPARE
   30 FREEWAT = 0.0
      RETURN
C-----ONLY PART OF THE FREE WATER FROZE.  COMPUTE THE BALANCE REMAINING
C----- BALANCE = EXISTING FREE WATER - AMOUNT FROZEN, WHERE
C----- AMOUNT FROZEN = CALORIES/(80.0 * 2.54)
   40 FREEWAT = FREEWAT + (CALOUT/203.2)
      RETURN
      END
```

Subroutine CANVAP

```
      SUBROUTINE CANVAP
C-----COMPUTE THE EVAPORATION FROM THE INTERCEPTED SNOW AS A FUNCTION OF
C----- THE CANOPY COVER DENSITY
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,DREADY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREADY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      ETFROM = 1.0
      EVAPOTR = EVAPOTR/COVDEN
      ONTREES = ONTREES - EVAPOTR
      IF(ONTREES) 10,20,20
   10 EVAPOTR = ONTREES + EVAPOTR
      ONTREES = 0.0
   20 RETURN
      END
```

Subroutine DIFMOD

```
      SUBROUTINE DIFMOD
C-----THIS SUBROUTINE WAS DERIVED FROM PROGRAM SIMTEM, A SNOWPACK
C----- TEMPERATURE DIFFUSION MODEL DEVELOPED BY LEAF (1970 STUDY PLAN
C----- FS-RM-1602, NO. 224, RMF+RES).  USING THE AVERAGE SURFACE TEMP
C----- AND THE GROUND TEMP AS BOUNDARY CONDITIONS, THE NEW AVERAGE
C----- SNOWPACK TEMPERATURE IS CALCULATED
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,DREADY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NDAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREADY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----
C-----DICTIONARY
C
C     CONST1 - THE FIRST CONSTANT IN THE EQUATION FOR THE SIMULATION
C     CONST2 - THE SECOND CONSTANT IN THE EQUATION FOR THE SIMULATION
C     H - THE DISTANCE BETWEEN NODES (CORRESPONDS TO THE -H- IN THE
C                  STUDY PLAN)
C-----
C-----COMPUTE THE DENSITY OF THE SNOWPACK (THE FUNCTION WAS DERIVED FROM
C----- OBSERVED CONDITIONS ON THE FRASER EXPERIMENTAL FOREST)
      DENSITY = (EXP((0.0179 * PREWEQV) + 3.02))/100.0
C-----COMPUTE THE DISTANCE BETWEEN THE TWO NODES IN CENTIMETERS
```

```
C-----OEPTH = PREWEQV/OENSITY
C-----H = (OEPTH/2)*2.54
      H = (PREWEQV/OENSITY) * 1.27
C-----THE THERMAL OIFFUSIVITY IS CALCULATEO FROM THE FUNCTION
C----- KV = 0.01/((2.751 - OENSITY)* 0.4B).  MATHEMATICAL STABILITY
C----- REQUIRES THAT THE VALUE OF THE QUANTITY (INTERVAL IN SECONOS *
C----- KV/H**2) BE LESS THAN 0.5.  WHEN A 24 HOUR INTERVAL IS USEO, THE
C----- SNOW OEPTH MUST EXCEEO 30 INCHES (20 PERCENT OENSITY) TO ACHIEVE
C----- STABILITY.  IN OROER TO INSURE STABILITY WITH SOMEWHAT SHALLOWER
C----- PACKS (ABOUT 1B INCHES), THE OAY IS OIVIOEO INTO 2 TIME INTERVALS
C----- OF 12 HOURS (43200 SECONOS)
C-----CONST1 = (43200 * 0.01/((2.751 - OENSITY) * 0.4B))/H**2
      CONST1 = 900.0/((2.751 - OENSITY)*H*H)
C-----THE MINIMUM WATER EQUIVALENT WHICH WILL ACHIEVE STABILITY USING
C----- THE ABOVE OENSITY FUNCTION IS 4.7 INCHES
      IF(CONST1 - 0.5) 20,10,10
C-----THE MOOEL IS UNSTABLE - INOICATE THAT IT IS NOT REAOY FOR USE NOW.
C----- (IT MAY BE INITIALIZEO AGAIN BY AN OBSERVEO PACK TEMPERATURE CARO
C----- ANO STABILITY WILL BE ASCERTAINEO FROM THE WATER EQUIVALENT AT
C----- THAT TIME)
   10 OREAOY = 0
      RETURN
C-----GET THE SECONO CONSTANT
   20 CONST2 = 1.0 - CONST1 - CONST1
C-----PERFORM THE SIMULATION IN TWO PARTS (ONE FOR EACH 12 HOUR PERIOO).
C----- -SIMTEM1- HOLOS THE THREE TEMPERATURES FROM THE PREVIOUS INTERVAL
C----- THAT ARE NEEOEO TO SIMULATE SIMTEM2, THE NOOE AT THE CENTER OF
C----- THE PACK.  SIMULATE THE FIRST 12 HOURS NOW
      SIMTEM2 = (CONST1 * (SIMTEM1(1) + SIMTEM1(3))) + (CONST2 * SIMTEM
     1(2))
C-----THE AVERAGE SNOWPACK TEMPERATURE IS THE AVERAGE OF THE 2 NOOES
C----- (MIOOLE ANO GROUNO) IN BOTH INTERVALS.  GROUNO TEMPERATURE IS
C----- CONSTANT, SO START THE AVERAGE NOW
      SIMTEM3 = SIMTEM1(3) + SIMTEM1(3) + SIMTEM2
C-----RESET -SIMTEM1- TO THE TEMPERATURES OF THE INTERVAL JUST SIMULATEO
C----- FOR USE IN THE SECOND 12 HOUR INTERVAL SIMULATION.  THE SURFACE
C----- AIR TEMPERATURE IS SPLIT INTO A LOW AVERAGE ( (MEAN+MIN)/2 ) ANO
C----- A HIGH AVERAGE ( (MEAN+MAX)/2 ) FOR USE WITH THE TWELVE HOUR
C----- INTERVALS.  USE THE LOW AVERAGE NOW
      SIMTEM1(1) = AMIN1 (0.0,(((TEMPMIN-32.0)*0.5555555556)+AVETEMC)/
     1 2.0)
      SIMTEM1(2) = SIMTEM2
C-----SIMULATE THE SECONO 12 HOURS ANO COMPUTE THE AVERAGE SNOWPACK
C----- TEMPERATURE
      SIMTEM2 = (CONST1 * (SIMTEM1(1) + SIMTEM1(3))) + (CONST2 * SIMTEM1
     1(2))
      SIMTEM3 = (SIMTEM3 + SIMTEM2)/4.0
C-----RESET -SIMTEM1- USING THE HIGH AVERAGE FOR USE ON THE FIRST
C----- INTERVAL OF THE NEXT OAY
      SIMTEM1(1) = AMIN1 (0.0,(((TEMPMAX-32.0)*0.5555555556)+AVETEMC)/
     1 2.0)
      SIMTEM1(2) = SIMTEM2
C-----CHECK TO SEE IF THE GROUNO TEMPERATURE SHOULO BE RAISEO
      IF(SIMTEM3 + 1.5) 60,40,30
   30 IF(SIMTEM3 + 0.5) 40,50,50
   40 IF(SIMTEM1(3).LT.-0.5) SIMTEM1(3) = -0.5
      RETURN
   50 SIMTEM1(3) = 0.0
   60 RETURN
      ENO
```

Subroutine EVTRAN

```
      SUBROUTINE EVTRAN
C-----COMPUTE THE EVAPORATION ANO TRANSPIRATION OURING THE GROWING
C----- SEASON
C-----
C-----OICTIONARY
C     AVABLE - THE FACTOR FOR AOJUSTING THE EVAPOTRANSPIRATION FOR
C                 AVAILABLE SOIL WATER
C     CANREF - THE FACTOR FOR AOJUSTING THE EVAPOTRANSPIRATION
C                 FOR CANOPY REFLECTIVITY
C-----
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,OREAOY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      ETFROM = 4.0
C-----GET THE AOJUSTMENT FACTOR FOR AVAILABLE SOIL WATER.  IF THE
C----- RECHARGE REQUIREMENTS ARE SATISFIEO (I.E., FIELO CAPACITY HAS
C----- BEEN REACHEO), MAXIMIZE THE ADJUSTMENT FACTOR
      IF(RECHRG) 20,20,10
   10 AVABLE = 1.0
      GO TO 80
C-----IN FORESTEO AREAS, USE THE MAXIMIZED FACTOR UNTIL THE RECHARGE
C----- REQUIREMENTS ARE HALF OF THE FIELO CAPACITY.  AT THAT POINT, USE
C----- THE LINEAR FUNCTION Y = MX + B, WHERE B = 0.0 TO GET THE FACTOR
   20 IF(COVOEN) 50,50,30
   30 IF(RECHRG + 2.65) 40,10,10
   40 AVABLE = 0.377 * (5.3 + RECHRG)
      GO TO 80
C-----IN CLEARINGS, ASSUME THAT EVAPOTRANSPIRATION OECREASES LINEARLY
C----- FROM THE MAXIMIZED VALUES AT FIELD CAPACITY TO ZERO AT
C----- THREE-FOURTHS OF FIELO CAPACITY
   50 IF(RECHRG + 1.325) 70,70,60
   60 AVABLE = (0.755 * (5.3 + RECHRG)) - 3.0
      GO TO 80
   70 EVAPOTR = 0.0
      RETURN
C-----COMPUTE THE FACTOR FOR AOJUSTING THE EVAPOTRANSPIRATION FOR CANOPY
C----- REFLECTIVITY (PROTECT AGAINST OIVISION BY ZERO - JUST OEFINE THE
C----- FACTOR FOR CLEARINGS AS THE MINIMUM VALUE)
   80 IF(COMAX) 90,90,100
   90 CANREF = 0.5
      GO TO 130
C-----COMPARE THE COVER OENSITY WITH THE MAXIMUM (CHECK FOR THINNING)
  100 IF(COVOEN - (COMAX/3.0)) 110,110,120
C-----FOR COVER OENSITIES THINNEO TO ONE-THIRO OF THE MAXIMUM OR LESS,
C----- USE THIS RELATIONSHIP
C-----CANREF = 1.0 - (0.5 - ((0.75*CO)/COMX))
  110 CANREF = 0.5 + ((0.75 * COVOEN)/COMAX)
      GO TO 130
C-----FROM MAXIMUM COVER OENSITY OOWN TO ONE-THIRO OF THAT VALUE, USE
C----- THE FOLLOWING RELATIONSHIP
C-----CANREF = 1.0 - (0.25 - ((0.15/(0.67*COMX))*(CO-(0.33*COMX))))
  120 CANREF = 0.75 + ((0.15/(0.67 * COMAX))*(COVOEN - (0.33 * COMAX)))
C-----PERFORM THE AOJUSTMENTS
  130 EVAPOTR = EVAPOTR * AVABLE * CANREF
C-----SEE IF THE EVAPOTRANSPIRATION WILL OEPLETE THE MANTLE STOARGE
C----- BELOW THE WILTING POINT.  IF SO, ALTER THE EVAPOTRANSPIRATION
C----- ACCOROINGLY
      IF(RECHRG - EVAPOTR + 5.3) 140,150,150
  140 EVAPOTR = RECHRG + 5.3
      RECHRG = -5.3
      RETURN
  150 RECHRG = RECHRG - EVAPOTR
      RETURN
      ENO
```

Subroutine LINK

```
      SUBROUTINE LINK (CALAIR,CALORIE,IRETURN)
C-----THIS SUBROUTINE IS THE INTERFACE BETWEEN THE RAOIATION BALANCE
C----- (SUBROUTINE RAOBAL) ANO THE OIFFUSION MOOEL (SUBROUTINE DIFMOO)
C-----
C-----OICTIONARY
C
C     CALOM - THE CALORIC LOSS OF GAIN AS COMPUTEO BY THE OIFFUSION
C                 MOOEL
C
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,OREAOY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RAOLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----SEE IF THE RAOIATION BALANCE IS AN ENERGY LOSS OR GAIN
      IF(CALORIE) 10,10,80
C-----THERE WAS A LOSS.  IF THIS IS STILL WINTER (NO FREE WATER), JUST
C----- GO AHEAD ANO USE THE OIFFUSION MOOEL
   10 IF(FREEWAT) 20,20,50
C-----USE THE OIFFUSION MOOEL TO SIMULATE THE CURRENT AVERAGE SNOWPACK
C-----TEMPERATURE
   20 IF(OREAOY.NE.1) GO TO 40
      CALL OIFMOO
      IF(OREAOY) 40,40,30
C-----NOW MAKE ANY NECESSARY AOJUSTMENTS IN THE RAOIATION BALANCE TO
C----- CAUSE THE PACK TEMPERATURE TO BE THE SAME AS -SIMTEM3-. GET THE
C----- OIFFERENCE BETWEEN THE CALORIE OEFICITS AS COMPUTEO BY THE
C----- OIFFERENT METHOOS
   30 CALOM = CALOEF + (SIMTEM3 * PREWEQV * 1.27)
C-----AOJUST THE LONG WAVE PORTION OF THE RAOIATION BALANCE BY THE
C----- OIFFERENCE BETWEEN THE CALORIES OERIVEO FROM THE DIFFUSION MOOEL
C----- ANO THE ENERGY BALANCE
      CALORIE = CALOM
      RAOLWN = CALORIE - RAOSWN
   40 IRETURN = 0
      RETURN
C-----THE LOSS IS USEO TO FREEZE PART OR ALL OF THE FREE WATER, BUT IT
C----- MAY NOT CREATE COLO CONTENT.  IF IT WOULO CREATE COLO CONTENT,
C----- RE-INITIALIZE THE OIFFUSION MOOEL TO 0 ANO AOJUST THE ENERGY
C----- BALANCE ACCOROINGLY
   50 CALL CALOSS (CALORIE)
      IF(FREEWAT - 0.05) 60,60,70
   60 SIMTEM1(1) = AMIN1 (AVETEMC,0.0)
      SIMTEM1(2) = 0.0
      SIMTEM1(3) = 0.0
      OREAOY = 1
C-----MAKE ANY NECESSARY AOJUSTMENTS TO THE ENERGY BALANCE TO COMPENSATE
C----- FOR THE COLO CONTENT THAT WOULO HAVE BEEN GENERATEO BY THIS LOSS
C----- ANO ZERO THE COLO CONTENT
      ENGBAL = ENGBAL + CALOEF
      RAOLWN = RAOLWN + CALOEF
      FREEWAT = 0.0
      CALOEF = 0.0
   70 IRETURN = 1
      RETURN
C-----THERE IS CALORIC INPUT TO THE PACK.  CHECK TO SEE IF CONOITIONS
C----- INDICATE THAT THE OIFFUSION MOOEL SHOULO BE TURNED OFF AND THE
C----- ENERGY BALANCE USEO FOR SPRINGTIME SIMULATION.  CONSIOER FIRST
C----- ANY COLO CONTENT (INCLUOING THAT OF THE PREVIOUS OAY ANO ANY
C----- CREATEO BY A SNOW EVENT ON THIS OAY).  IF THERE IS COLO CONTENT,
C----- CHECK THE AVERAGE AIR TEMPERATURE ANO THE SNOWPACK TEMPERATURE
C----- FROM THE PREVIOUS OAY FOR ARBITRARILY CHOSEN SPRINGTIME
C----- CONDITIONS ANO IF ALL ARE NOT SATISFIEO, GO AHEAO ANO USE THE
C----- OIFFUSION MOOEL
   80 IF(CALOEF) 170,170,90
C-----0.889 = 1.27 * 0.7 OEGREES C (ARBITRARY TEMP)
   90 IF(AVETEMC.LE.0.0.OR.CALOEF.GT.PREWEQV*0.889) GO TO 20
C-----SINCE SPRINGTIME CONOITIONS PREVAIL, RECOMPUTE THE BACK RADIATION
C----- ANO THE NET RAOIATION BALANCE (REMEMBER, IF THERE IS SNOW, THE
C----- LONGWAVE IS ASSUMEO TO BE ZERO, SO THERE WOULO BE NO NEEO TO MAKE
C----- ANY AOJUSTMENTS)
      IF(NOAYSNO) 140,140,100
  100 USE = (TEMPMIN - 32.0) * 0.5555555556
      IF(USE.GT.0.0) USE = 0.0
```

```
      CALSNOW = 1.17E-7 * ((USE + 273.16) ** 4)
      IF(PRECIP) 11D,11D,120
  110 RADLWN = ((1.0 - COVOEN) * ((0.757 * CALAIR) - CALSNOW)) + (COVOEN
     1 * (CALAIR - CALSNOW))
      GO TO 130
  12D RAOLWN = CALAIR - CALSNOW
  130 CALORIE = RADSWN + RADLWN
C-----RE-INITIALIZE THE OIFFUSION MOOEL TO THESE CONOITIONS (BUT IF THE
C----- INPUT IS MORE THAN ENOUGH TO WIPE OUT THE CALORIE OEFICIT, JUST
C----- LET IT BRING THE PACK TO ISOTHERMAL.  IN THIS WAY, TWD CONSECU-
C----- TIVE OAYS OF INPUT ARE REQUIREO TO GENERATE FREE WATER)
  140 COMPARE = CALORIE - CALOEF
      IF(COMPARE) 160,150,150
C-----INITIALIZE THE OIFFUSION MODEL TD ISOTHERMAL CONOITIONS
  150 SIMTEM1(1) = 0.0
      SIMTEMI(2) = 0.D
      SIMTEM1(3) = 0.0
      SIMTEM3 = 0.0
      OREAOY = 1
      GO TO 3D
C-----REOEFINE THE SURFACE TEMPERATURE ANO COMPUTE THE NEW AVERAGE PACK
C----- TEMPERATURE.  THEN COMPUTE THE MIDOLE NOOE AS A FUNCTIDN OF THAT
C----- AVERAGE, THE SURFACE TEMPERATURE ANO THE GROUNO TEMPERATURE
C----- (WHICH REMAINEO UNCHANGEO)
  160 SIMTEM1(1) = AMIN1 (0.0,AVETEMC)
      SIMTEM3 = COMPARE/(PREWEQV * 1.27)
      SIMTEMI(2) = (3.0 * SIMTEM3) - SIMTEM1(I) - SIMTEM1(3)
      SIMTEM1(3) = 0.0
      OREAOY = 1
      GO TO 30
C-----THERE IS INPUT TO THE PACK ANO THE PACK IS ALREAOY ISOTHERMAL.  IF
C----- THIS ENERGY WILL CREATE AT LEAST D.05 INCH (ARBITRARY AMOUNT) OF
C----- FREE WATER, SET THE OIFFUSION MDOEL TO STANOBY STATUS ANO LET THE
C----- ENERGY BALANCE TAKE ITS COURSE
  17D IF(FREEWAT + (CALORIE/203.2) - D.05) 150,18D,1BD
  180 OREAOY = 0
      IRETURN = D
      RETURN
      ENO
```

Subroutine MIXTURE

```
      SUBROUTINE MIXTURE
C----THIS SUBROUTINE CONTROLS THE COMPUTATIONS FOR A PRECIPITATION
C----- EVENT THAT IS A MIXTURE OF SNDW ANO RAIN
C-----
      COMMON/ONLYCDR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,OREAOY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      CDMMDN/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----OICTIONARY
C-----
C     AMTRAIN - THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN
C     TFORAIN - THE TEMPERATURE FOR COMPUTING THE OEPLETION OF THE TOTAL
C                 CALORIE DEFICIT CAUSEO BY THE RAIN (OEGREES C)
C     TFORSNU - THE TEMPERATURE FOR COMPUTING THE CONTRIBUTION OF THE
C                 SNOW TO THE TOTAL CALORIE OEFICIT (OEGREES C)
C-----
C-----COMPUTE THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN
C----- AMOUNT RAIN = P * (B/A), WHERE
C----- P = PRECIPITATION IN INCHES
C----- B = OAILY MAXIMUM TEMPERATURE - BASE TEMPERATURE (OEGREES F)
C----- A = OAILY MAXIMUM TEMPERATURE - MINIMUM TEMPERATURE (OEGREES F)
      B = TEMPMAX - BASTEMF
      A = TEMPMAX - TEMPMIN
      AMTRAIN = PRECIP * (8/A)
C-----NOW COMPUTE THE AVERAGE TEMPERATURES (OEGREES C) WHICH PROOUCE
C----- SNOW ANO RAIN
      TFORSNO = (TEMPMIN + BASTEMF - 64.D) * 0.277777777B
      TFORAIN = (TEMPMAX + BASTEMF - 64.0) * 0.277777777B
C-----COMPUTE THE EFFECT OF THE SNOW ON THE SNOWPACK
      CALL SNOWEO (TFORSNO,PRECIP-AMTRAIN)
C-----COMPUTE THE EFFECT OF THAT PORTION OF THE PRECIPITATION OCCURRING
C----- AS RAIN ON THE SNOWPACK
      CALL RAINEO (TFORAIN,AMTRAIN)
      RETURN
      ENO
```

Function PACKREF

```
      FUNCTION PACKREF (OUMMY)
C-----GET THE REFLECTIVITY OF THE SNOWPACK
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,OREAOY,ENGBAL,
     1 ENGBALI,FREEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----
C-----OICTIONARY
C
C     PASTINT - A VARIABLE SET EQUAL TO -NOAYSNO- AND ALTEREO AS NEEOEO
C                 TO CHOOSE THE PROPER REFLECTIVITY FUNCTION
C     REFACUM - A REFLECTIVITY FUNCTION FOR THE SNOWPACK OURING THE
C                 ACCUMULATION PHASE OF THE SNOWPACK
C     REFMELT - A REFLECTIVITY FUNCTION FOR THE SNOWPACK OURING THE
C                 MELT PHASE OF THE SNOWPACK
C-----
      OIMENSION REFACUM(15),REFMELT(15)
      INTEGER PASTINT
      OATA REFACUM/.BO, .77, .75, .72, .7D, .69, .68, .67, .66, .65,
     I .64, .63, .62, .61, .60/
      OATA REFMELT/.72, .65, .60, .58, .56, .54, .52, .50, .48, .46,
     1 .44, .43, .42, .41, .40/
      PASTINT = NDAYSNO
      IF(NOAYSNO) BD,BO,10
C-----USE THE SAME FUNCTION AS LAST TIME
   10 IF(LASTUSO) 20,2D,5D
C-----ACCUMULATIDN PHASE - AFTER 15 OAYS, USE THE MELT FUNCTION
C----- STARTING AT THE FOURTH OAY
   20 IF(PASTINT - 15) 30,30,4D
   30 PACKREF = REFACUM(PASTINT)
      RETURN
   40 PASTINT = PASTINT - 11
C-----MELT FUNCTION - AFTER 15 OAYS, USE A CONSTANT 40 PERCENT
   50 IF(PASTINT - 15) 70,70,60
   60 PASTINT = 15
   70 PACKREF = REFMELT(PASTINT)
      RETURN
C-----THERE IS NEW SNOW - OETERMINE IF THE FUNCTION IS TO BE RE-
C----- INITIALIZEO
   BD IF(TEMPMAX - THRSHLO) 90,90,10
C-----IT IS, SO SEE WHICH FUNCTION IS TO BE USEO
   90 IF(CALOEF) 110,110,100
  100 PACKREF = 0.91
      LASTUSD = 0
      RETURN
C-----THE PACK IS ISOTHERMAL, BUT IF THE ENERGY BALANCE FROM THE
C----- PREVIOUS INTERVAL WAS NEGATIVE, USE THE ACCUMULATION PHASE
C----- FUNCTION ANYWAY
  11D IF(ENGBALI) 100,120,I20
  I20 PACKREF = 0.B1
      LASTUSO = I
      RETURN
      ENO
```

Subroutine RADBAL

```
      SUBROUTINE RAOBAL
C-----THIS SUBROUTINE COMPUTES THE RAOIATION BALANCE ANO TRANSFERS
C----- CDNTROL TO THE OIFFUSION MOOEL IF IT IS NEEOEO
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,OREAOY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSD,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----
C-----DICTIONARY
C-----
C     CALAIR - POTENTIAL LONGWAVE CALORIC INPUT AT AIR TEMPERATURE
C     CALORIE - CALORIES OF HEAT ABSORBEO OR RELEASEO BY THE SNOWPACK
C                 FROM THE NET RAOIATION BALANCE
C     CALSNOW - POTENTIAL LONGWAVE CALORIC LOSS AT SNOW TEMPERATURE
C     SNOCAN - THE LONGWAVE RADIATION BALANCE BETWEEN THE SNOW ANO THE
C                 CANOPY
C     SNOSKY - THE LONGWAVE RAOIATION BALANCE BETWEEN THE SNOW ANO THE
C                 SKY
C-----CDMPUTE THE CALDRIC INPUT FROM NET SHORT WAVE RAOIATION AS A
C----- FUNCTION OF THE SNOWPACK REFLECTIVITY
      RAOSWN = RAOIN * (1.0 - PACKREF (0.D)) * TCOEFF
C-----IF THE PACK IS ACCUMULATING, BUT IS NOT OEEP ENOUGH FOR STABILITY
C----- IN THE OIFFUSION MOOEL, USE THE FOLLOWING SIMPLIFIEO METHOO FOR
C----- OERIVING THE RAOIATION BALANCE
      IF(PHASE) 60,10,100
   10 IF(PREWEQV - 4.7) 2D,50,50
C-----USE ONLY THE SHORTWAVE INPUT (THIS IMPLIES THAT THE ONLY COLO
C----- CONTENT GENERATEO IN THE ACCUMULATING PACK IS THAT OF NEW SNOW)
   20 CALORIE = RAOSWN
      RAOLWN = 0.0
      CALL CALIN (CALORIE)
C-----IF THE MEAN TEMPERATURE WAS LESS THAN OR EQUAL TO 0 C, OO NOT
C----- ALLOW ANY MELT OR FREE WATER
      IF(AVETEMC) 30,30,40
   30 PREWEQV = PREWEQV + WATERIN
      RAOLWN = -ENGBAL
      ENGBAL = 0.0
      WATERIN = 0.0
      FREEWAT = 0.0
      CALOEF = 0.D
   40 RETURN
C-----THE PACK HAS JUST REACHEO A SUFFICIENT OEPTH.  INITIALIZE THE
C----- OIFFUSION MOOEL, BUT RETAIN PSEUOO-CONTROL UNTIL THE OIFFUSION
C----- MOOEL IS WELL ALONG INTO STABLE CONTROL
   50 PHASE = -1
      OREAOY = 1
C-----START THE PACK AT -3 C (CAL OEF = PACK TEMP * PREWEQV * 1.27)
C-----3.B1 = 3 * 1.27
      CALOEF = 3.81 * PREWEQV
      RAOLWN = - CALOEF - RAOSWN - ENGBAL
      ENGBAL = - CALOEF
      SIMTEM1(1) = AMIN1 (AVETEMC,0.0)
      SIMTEM1(2) = -3.0
      SIMTEMI(3) = -I.5
      FREEWAT = 0.0
      RETURN
C-----THE OIFFUSION MOOEL HAS BEEN INITIALIZEO PREVIOUSLY.  IF IT IS
C----- STILL STABLE ANO IF THE PACK IS OEEP ENOUGH TO INSURE CONTINUEO
C----- STABILITY UNTIL MELT, RELINQUISH CONTROL COMPLETELY TO THE
C----- NORMAL METHOO OF COMPUTING THE RAOIATION BALANCE, INTERFACEO WITH
C----- THE OIFFUSION MOOEL
   60 IF(OREAOY) 100,70,80
   70 PHASE = 0
      GO TO 10
   80 CALORIE = RAOSWN
```

```
      CALAIR = 0.D
      RADLWN = 0.D
      IFIPREWEQV - 5.D) 16D,16D,90
   90 PHASE = 1
C-----USE THE NORMAL METHOD OF COMPUTING THE RADIATION BALANCE.  IF ANY
C----- OF THE PRECIP WAS SNOW, THE NET LONG WAVE RADIATION BALANCE IS
C----- ASSUMED TO BE ZERO
  1DO IF(NOAYSNO) 110,11D,12D
  110 RADLWN = 0.D
      CALAIR = 0.0
      GO TO 15D
C-----TO COMPUTE THE LONG WAVE RADIATION COMPONENTS, CONVERT THE AIR
C----- AND SNOW TEMPERATURES TO POTENTIAL CALORIES BY THE STEFAN -
C----- BLOTZMANN FUNCTION, CALORIES = S * (T ** 4), WHERE
C----- S = 1.17E-7 CAL/((CM**2)(DEGREES KELVIN)**4), AND
C----- T = ABSOLUTE TEMPERATURE (DEGREES KELVIN)
  12D CALAIR = 1.17E-7 * ((AVETEMC + 273.16) ** 4)
      USE = AVETEMC
C-----IF THE SNOWPACK IS ISOTHERMAL, USE THE MINIMUM TEMPERATURE FOR
C----- COMPUTING THE BACK RADIATION
      IF(CALDEF.EQ.D.O) USE = (TEMPMIN - 32.D) * 0.5555555556
C-----UNDER NO CIRCUMSTANCES MAY THE TEMPERATURE FOR COMPUTING THE BACK
C----- RADIATION BE GREATER THAN ZERO
      IF(USE.GT.0.0) USE = D.0
      CALSNOW = 1.17E-7 * ((USE + 273.16) ** 4)
C-----COMPUTE THE LONG WAVE RADIATION COMPONENTS AS A FUNCTION OF THE
C----- FIRST, DETERMINE WHETHER THE SKIES ARE CLEAR OR CLOUDY
      IF(PRECIP) 13D,130,14D
C-----WITH CLEAR SKIES, THE DOWNWARO LONGWAVE RADIATION COEFFICIENT IS
C----- .757 (RUNOFF FROM SNOWMELT, EM111D-2-14D6, US ARMY CORPS OF
C----- ENGINEERS, 1960, PAGE 7)
  130 SNOSKY = (1.0 - COVOEN) * (I0.757 * CALAIR) - CALSNOW)
C-----THE OOWNWARO LONGWAVE RADIATION COEFFICIENT IS 1.0 BENEATH THE
C----- FOREST CANOPY (OR BENEATH CLOUOY SKIES)
      SNOCAN = COVOEN * (CALAIR - CALSNOW)
      RADLWN = SNOCAN + SNOSKY
      GO TO 15D
C-----WITH CLOUOY SKIES, WHEN THE OOWNWARO LONGWAVE RAOIATION COEFFI-
C----- CIENT IS 1.O INSTEAO OF .757, THE ABOVE THREE EQUATIONS MAY BE
C----- REOUCEO ALGEBRAICALLY TO THE FOLLOWING SINGLE EQUATION
  140 RADLWN = CALAIR - CALSNOW
C-----COMPUTE THE CALORIC INPUT OR LOSS FROM THE NET EFFECT OF SHORT
C----- WAVE ANO LONG WAVE RADIATION
  150 CALORIE = RAOSWN + RAOLWN
C-----THE SNOWPACK TEMPERATURE OIFFUSION MODEL (LEAF, 1970, STUOY PLAN
C----- FS-RM-1602, NO. 224.  ROCKY MOUNTAIN FOREST ANO RANGE EXP STA) IS
C----- INCORPORATEO TO CONTROL THE SNOWPACK TEMPERATURE ANO COLO CONTENT
C----- OURING NON-ISOTHERMAL CONOITIONS.  SEE NOW IF THE OIFFUSION MODEL
C----- MAY BE USED (OREADY MAY NOT BE -1 ANO PASS THROUGH LINK SINCE IT
C---- IS NOT OESIGNEO TO WORK WITH IT.  THE -1 IS USED TO INDICATE THAT
C----- THE RAOIATION ROUTINES ARE TO BE USEO EXCLUSIVELY).  IF IT MAY BE
C----- USEO, PASS THROUGH THE LINKING ROUTINE WHICH INTERFACES THE
C----- DIFFUSION MODEL AND THE RADIATION ROUTINES
      IF(OREAOY) 170,160,160
  160 CALL LINK (CALAIR,CALORIE,IRETURN)
      IF(IRETURN) 170,170,190
  170 IF(CALORIE) 180,190,200
  180 CALL CALOSS (CALORIE)
  190 RETURN
  200 CALL CALIN (CALORIE)
      RETURN
      END
```

Subroutine RAINED

```
      SUBROUTINE RAINED (TFORAIN,AMTRAIN)
C-----THIS SUBROUTINE COMPUTES THE EFFECT OF RAIN ON SNOW
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALDEF,COMAX,COVDEN,OREAOY,ENGBAL,
     1 ENGBAL1,FREEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREADY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----
C-----OICTIONARY
C     AMTRAIN - THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN (INCHES)
C     CALRAIN - THE DEPLETION OF THE TOTAL CALORIE DEFICIT BY THIS RAIN
C                    (CALORIES)
C     TFORAIN - THE TEMPERATURE FOR COMPUTING THE OEPLETION OF THE TOTAL
C                    CALORIE OEFICIT CAUSED BY THIS RAIN (OEGREES C)
C-----
C-----AOO THIS AMOUNT OF PRECIPITATION TO THE PREDICTEO WATER EQUIVALENT
      PREWEQV = PREWEQV + AMTRAIN
C-----SEE IF THERE IS A CALORIE OEFICIT IN THE PACK
      IFICALOEF) 50,50,10
C-----COMPUTE THE AMOUNT OF RAIN AT THIS TEMPERATURE THAT IS NEEDED TO
C----- WIPE OUT THE DEFICIT AND COMPARE IT WITH THE ACTUAL AMOUNT
   10 CALRAIN = (8O.O + TFORAIN) * 2.54
      AMTNEED = CALDEF/CALRAIN
      COMPARE = AMTRAIN - AMTNEED
      IF(COMPARE) 30,20,40
C-----THERE WAS JUST ENOUGH TO WIPE OUT THE OEFICIT
   20 CALOEF = 0.0
      ENGBAL = ENGBAL + CALRAIN
      RETURN
C-----THERE WAS NOT ENOUGH TO WIPE IT OUT COMPLETELY.  JUST OEPLETE
C----- THE DEFICIT
   30 CALDEF = CALOEF - (CALRAIN * AMTRAIN)
      ENGBAL = ENGBAL + (CALRAIN * AMTRAIN)
      RETURN
C-----THERE WAS MORE THAN ENOUGH TO WIPE OUT THE OEFICIT.  THE AMOUNT
C----- OF RAIN NOT FROZEN IS FREE WATER
   40 FREEWAT = COMPARE
      CALL CALIN (TFORAIN * COMPARE * 2.54)
      RETURN
C-----ALL OF THE RAIN IS ADOED TO THE FREE WATER AND CONTRIBUTES CALORIC
C----- INPUT TO THE PACK
   50 FREEWAT = FREEWAT + AMTRAIN
      CALL CALIN (TFORAIN * AMTRAIN * 2.54)
      RETURN
      END
```

Subroutine SNOWED

```
      SUBROUTINE SNOWEO (TFORSNO,AMTSNOW)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF A SNOW EVENT ON THE
C----- SNOWPACK
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTDNOW,DBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,CDMAX,COVDEN,DREADY,ENGBAL,
     1 ENGBAL1,FRFEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEQV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLD,VEGTYPE
      INTEGER DREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFRDM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      REAL INTRCPT
C-----
C-----DICTIONARY
C-----
C     AMTSNOW - THE AMOUNT OF PRECIPITATION OCCURRING AS SNOW (INCHES)
C     CALSNOW - THE CONTRIBUTION OF THIS SNOW TO THE TOTAL CALORIE
C                    DEFICIT (CALORIES)
C     INTRCPT - THE AMOUNT OF SNOW INTERCEPTEO DURING THIS PRECIP EVENT
C     TFORSNO - THE TEMPERATURE FOR COMPUTING THE CONTRIBUTION OF THIS
C                    SNOW TO THE TOTAL CALORIE OEFICIT (OEGREES C)
C-----
C-----OO NOT ALLOW ANY INTERCEPTION IN JULY ANO AUGUST
      IF(OATE(1).EQ.7.OR.OATE(1).EQ.B) GO TO 10
C-----OETERMINE THE AMOUNT OF INTERCEPTEO SNOW AS A FUNCTION OF COVER
C----- COMPOSITION ANO COVER OENSITY
      IF(COMAX) 10,1D,20
   10 INTRCPT = 0.0
      GO TO 8O
   20 IF(VEGTYPE - 1) 30,30,40
C-----LOOGEPOLE PINE
   3D PERCENT = 0.1D
      GREATST = 0.20
      GO TO 50
C-----SPRUCE FIR
   40 PERCENT = 0.15
      GREATST = 0.30
   5D INTRCPT = AMTSNOW * PERCENT * (COVDEN/CDMAX)
      IF(ONTREES + INTRCPT - GREATST) 70,70,60
   6D INTRCPT = GREATST - ONTREES
   70 ONTREES = ONTREES + INTRCPT
   8O NOAYSNO = 0
C-----AOO THIS AMOUNT OF PRECIPITATION TO THE PREDICTEO WATER EQUIVALENT
      PREWEQV = PREWEQV + AMTSNOW - INTRCPT
C-----THE SNOW FALLING WHEN THE TEMPERATURE IS BETWEEN 35 ANO 32 DEGREES
C----- OOES NOT ALTER THE CALORIC OEFICIT
      IF(TFORSNO.GE.D.D) RETURN
C-----COMPUTE THE CALORIE DEFICIT FOR THIS SNOW BY THE EOUATION
C----- CALORIE OEFICIT = S(I)*OELTA T*P, WHERE
C----- S(I) = SPECIFIC HEAT OF ICE (.5 CAL/CM/OEGREES C),
C----- OELTA T = CHANGE IN TEMPERATURE WITH RESPECT TO FREEZING (0.0
C-----  OEGREES CENTIGRAOE), ANO
C----- P = PRECIPITATION IN CM (CONVERSION FACTOR = 2.54 CM/IN).
C----- THEREFORE, CALORIE DEFICIT = D.5 * (TFORSNO) * (AMTSNOW * 2.54)
      CALL CALOSS (TFORSNO * (AMTSNOW - INTRCPT) * 1.27)
      RETURN
      ENO
```

Subroutine SNOWVAP

```
      SUBROUTINE SNOWVAP
C-----COMPUTE THE EVAPORATION FROM THE SURFACE OF THE SNOWPACK AS A
C----- FUNCTION OF THE COVER OENSITY AND REDUCE THE PACK ACCORDINGLY
      COMMON/ONLYCOR/ AVETEMC,BASTEMF,CALOEF,COMAX,COVOEN,DREAOY,ENGBAL,
     1 ENGBALI,FREEWAT,LASTUSO,NOAYSNO,ONTREES,PHASE,PREWEOV,RECHRG,
     2 SIMTEM1(3),SIMTEM3,TCOEFF,THRSHLO,VEGTYPE
      INTEGER OREAOY,PHASE,VEGTYPE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      ETFROM = 2.0
      EVAPOTR = (1.D - COVOEN) * EVAPOTR
      PREWEQV = PREWEOV - EVAPOTR
      RETURN
      ENO
```

Subroutine ETCODE

```
      SUBROUTINE ETCOOE (ETFROM,COMPS12)
C-----KEEP TRACK OF WHICH SOURCES WERE USEO FOR EVAPOTRANSPIRATION
      IF(ETFROM - 2.0) I0,20,3D
C-----EVAPORATION FROM INTERCEPTED SNOW ON CANOPY (ETFROM = 1)
   1D IF(COMPS12.NE.1.0.AND.COMPSI2.NE.3.0.ANO.COMPS12.NE.5.D.ANO.
     1 COMPS12.NE.7.0) COMPS12 = COMPSI2 + ETFROM
      RETURN
C-----EVAPORATION FROM SNOWPACK (ETFROM = 2)
   20 IF(COMPS12.NE.2.0.ANO.COMPS12.NE.3.0.ANO.COMPS12.LT.6.0) COMPS12 =
     I COMPSI2 + ETFROM
      RETURN
C-----EVAPOTRANSPIRATION FROM MELT, PRECIP OR STORAGE (ETFROM = 4)
   30 IF(COMPS12.LT.4.0) COMPSI2 = COMPS12 + ETFROM
      RETURN
      END
```

Subroutine GENDATA

```
      SUBROUTINE GENDATA (N)
C-----GENERATE THE DATA FOR THIS SUBSTATION
C-----
C-----DICTIONARY
C
C     00 - THE EXACT POINT IN THE OEGREE-OAY TABLE WHICH IS TO BE USED
C                IN THE COMPUTATION OF THE INCOMING RADIATION
C     DOFACT - THE TABLE OF AOJUSTMENTS FACTORS FOR COMPUTING THE
C                INCOMING RADIATION
C     001 - A REAL, TRUNCATEO VALUE OF -00- USED IN INTERPOLATION
C     ET - THE ADJUSTEO POTENTIAL EVAPOTRANSPIRATION (MAINTAINEO FOR
C                THE REOEFINITION OF -EVAPOTR- BY THE ALTERNATIVES
C     RADHORZ - THE INCOMING RAOIATION COMPUTEO FROM THE POTENTIAL AT
C                A HORIZONTAL SURFACE
C
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),CDMAX(25),COVOEN(25)
      COMMON DREAOY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMDO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCDEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOID(6)
      COMMON YEARS(20),YYMMOO
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOO
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/RAO/FRACTON,ISUB
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRD,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      EQUIVALENCE (OATE(1),MONTH)
      OIMENSION OOFACT(26)
      OATA OOFACT/ .20, .35, .45, .51, .56, .59, .62, .64, .655, .67,
     1 .682, .69, .70, .71, .715, .72, .722, .724, .726, .728, .73,
     2 .734, .738, .742, .746, .75/
C-----ADJUST THE TEMPERATURES
      IF(OATE(3) - 67) 10,20,20
   10 I = 5
      GO TO 30
   20 I = 3
   30 TEMPMIN = AIRTEMC(N,I) + (TMNMSTR * AIRTEMC(N,I+1))
      TEMPMAX = AIRTEMC(N,1) + (TMXMSTR * AIRTEMC(N,2))
      IF(TEMPMAX.GE.TEMPMIN) GO TO 40
      XXX = TEMPMAX
      TEMPMAX = TEMPMIN
      TEMPMIN = XXX
C-----COMPUTE THE INCOMING RAOIATION AT THE BASE STATION FROM THE
C----- POTENTIAL BY THE OEGREE-OAY METHOO
   40 GO TO (50,50,50,50,60,70,70,70,60,50,50,50),MONTH
C-----OCTOBER - APRIL, DEGREE OAYS = .44 * TEMPMAX - 15.9 (+1.0 FOR
C----- SUBSCRIPTING)
   50 00 = (0.44 * TEMPMAX) - 14.9
      GO TO 100
C-----MAY AND SEPTEMBER, OEGREE OAYS = .53 * TEMPMAX - 19.5 (+1.0 FOR
C----- SUBSCRIPTING)
   60 00 = (0.53 * TEMPMAX) - 18.5
      GO TO 100
C-----JUNE, JULY ANO AUGUST, OEGREE OAYS = .63 * TEMPMAX - 24.1 (+1.0
C----- FOR SUBSCRIPTING), EXCEPT ON OAYS WITH PRECIP.  OURING THESE
C----- MONTHS, USE A CONSTANT 44 PERCENT ON PRECIP OAYS
   70 IF(PPTMSTR) 90,90,80
   80 RAOHORZ = POTRAO * 0.44
      GO TO 150
   90 DO = (0.63 * TEMPMAX) - 23.I
C-----WATCH FOR THE BOUNDARY VALUES, 0. ANO 25.  (WITH THE 1.0 AOOEO
C----- ABOVE, THE SUBSCRIPTS FOR THE TABULAR VALUES VARY FROM 1 TO 26)
  100 IF(00 - 1.0) 110,110,120
C-----USE THE FIRST TABLE VALUE (NO INTERPOLATION IS NECESSARY)
  110 RADHORZ = POTRAO * OOFACT(1)
      GO TO 150
  120 IF(00 - 26.0) 140,130,130
C-----USE THE LAST TABLE VALUE (NO INTERPOLATION IS NECESSARY)
  130 RAOHORZ = PCTRAO * OOFACT(26)
      GO TO 150
C-----THE SUBSCRIPT IS IN THE PROPER RANGE.  OBTAIN THE INTERPOLATION
C----- FRACTION ANO SUBSCRIPTS THROUGH TRUNCATION OF -DD-
  140 JI = DO
      001 = J1
      J = J1 + I
C-----THE TERM (00-001)/1.0 IS THE INTERPOLATION FRACTION
      RAOHORZ = POTRAO * (OOFACT(J1) + ((OOFACT(J) - OOFACT(JI)) * (DD -
     1 001)))
C-----AOJUST THE POTENTIAL EVAPOTRANSPIRATION AS COMPUTED BY THE HAMON
C----- METHOO FOR AVAILABLE RAOIATION AS A PERCENT OF POTENTIAL
  150 EVAPOTR = ETDAILY(N,MONTH) * (RAOHORZ/POTRAO)
      ET = EVAPOTR
C-----AOJUST THE RAOIATION AT THE BASE STATION FOR SLOPE ANO ASPECT
      RADIN = RAOHORZ * (SLPASP(N,ISUB) + ((SLPASP(N,ISUB+1) - SLPASP(N,
     1 ISUB)) * FRACTON))
C-----AOJUST THE PRECIP TO ENSURE REACHING THE PEAK WATER EQUIVALENT
      IF(PPTMSTR) 160,160,170
  160 PRECIP = 0.0
      RETURN
  170 IF(PEAKPPT(N,IYR) - PPTONOW) 190,190,180
  180 PRECIP = PPTMSTR * ((PEAKWE(N,IYR) - PREWEQV(N))/(PEAKPPT(N,IYR)
     1 - PPTONOW))
      RETURN
  190 PRECIP = PPTMSTR
      RETURN
      END
```

Subroutine PLOTTER

```
      SUBROUTINE PLOTTER
C-----PLOT THE INFORMATION.  THE NORMAL SCALE IS 20 PRINT POSITIONS = 1
C----- INCH, BUT SEVERAL OF THE PLOTS HAVE AOOITIONAL SCALE FACTORS AS
C----- EXPLAINED BELOW TO ENHANCE THEIR VISIBLE REPRESENTATIONS
C-----
C-----DICTIONARY
C
C     BOUNDL - THE LOWER BOUNOARY FOR VALUES TO BE PLOTTED IN EACH OF
C                THE THREE LEVELS (AND THE PSEUDO FOURTH LEVEL)
C     BOUNDU - THE UPPER BOUNOARY FOR VALUES TO BE PLOTTEO IN EACH OF
C                THE THREE LEVELS (ANO THE PSEUOO FOURTH LEVEL)
C     LETTER - THE ONE OIGIT SYMBOL TO BE PLOTTEO FOR EACH VARIABLE.
C                ALL VARIABLES FOR ALTERNATIVES ARE PLOTTEO AS -A- ANO
C                ARE PLOTTED IN THE SAME LEVEL AS THEIR NORMAL
C                COUNTERPART TO IOENTIFY THEM
C     POINT - THE ARRAY WHICH REPRESENTS ONE LINE ON THE PLOT.  IT IS
C                OIVIOEO INTO THREE LEVELS (INDEPENDENT PLOTS), WITH A
C                BASE LINE PRINTING FOR EACH AT POSITIONS 1, 42, 83
C                ANO 124.  THIS LEAVES 40 POSITIONS BETWEEN THE LINES
C                FOR PLOTTING PURPOSES
C     RAISE - THE QUANTITY NEEOEO TO RAISE THE CURVE TO THE PROPER LEVEL
C     SCALE - THE SCALING FACTOR FOR EACH OF THE VARIABLES.  EACH
C                INCLUDES THE NORMAL SCALING FACTOR, 20.0, ANO ANY
C                OTHER FACTOR OEEMEO NECESSARY, AS EXPLAINEO BELOW
C     TOPLOT - AN ARRAY OF LEVEL INOICATORS FOR EACH VARIABLE TO BE
C                PLOTTEO.  IF IT IS ZERO, THE VARIABLE WILL NOT BE
C                PLOTTEO.  THE VALUE OF TOPLOT MUST BE 1, 2 OR 3 FOR
C                ALL VARIABLES EXCEPT STORAGE.  SINCE STORAGE IS A
C                NEGATIVE VALUE ANO PRINTS BELOW THE BASE LINE, IT MAY
C                NOT BE PRINTEO AS PART OF LEVEL 1.  IT MAY, HOWEVER,
C                BE ASSIGNEO TO THE PSEUOO LEVEL 4, ANO THUS WILL
C                PRINT BENEATH THE TOP MOST BASE LINE
C
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVDEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETOAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLO(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER OREADY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOO
      COMMON/FOROATA/ FOOTNOT(26),MAXLINE
      INTEGER FOOTNOT
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYOR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/PLOTS/PLOT(11)
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      INTEGER BOUNOL(4),BOUNOU(4),POINT(124)
      OIMENSION LETTER(11),RAISE(4),SCALE(11)
      EQUIVALENCE (OATE(2),IOAY)
      OATA BOUNOL,BOUNOU,RAISE/1,42,83,83,42,83,124,124,1.5,42.5,83.5,
     1 124.5/
      OATA POINT/1H.,40*IH ,1H.,40*1H ,1H.,40*1H ,1H./
C-----HYOROGRAPH - MAX VALUE = 0.5, MULTIPLY BY 4 AS WELL AS 20
      OATA LETTER(I),SCALE(1)/1HH,80.0/
C-----WATER EQUIVALENT - MAX VALUE = 30.0, OIVIOE BY 15 I1.33 = 20/15)
      OATA LETTER(2),LETTER(7),SCALE(2),SCALE(7)/1HW,1HA,2*1.33/
C-----INPUT - MAX VALUE = 2.0, NO EXTRA SCALING NEEOEO
      OATA LETTER(3),LETTER(8),SCALE(3),SCALE(8)/1HI,1HA,2*20.0/
C-----EVAPOTRANSPIRATION - MAX VALUE = 0.5, MULTIPLY BY 4 ANO 20
      OATA LETTER(4),LETTER(9),SCALE(4),SCALE(9)/1HE,1HA,2*80.0/
C-----STORAGE REQUIREMENTS - MIN VALUE = -5.3 (7.547 = 20/(5.3/2))
      OATA LETTER(5),LETTER(10),SCALE(5),SCALE(10)/1HS,1HA,2*7.547/
C-----RUNOFF - MAX VALUE = 2.0, NO EXTRA SCALING NEEOEO
      OATA LETTER(6),LETTER(11),SCALE(6),SCALE(11)/1HR,1HA,2*20.0/
C-----SCALE EACH VARIABLE THAT IS TO BE PLOTTEO, RAISE IT TO THE PROPER
C----- LEVEL ANO IF IT IS WITHIN THE BOUNOARIES FOR THAT LEVEL, STORE
C----- THE CHARACTER FOR THE PLOT
      00 20 I = 1,11
```

```
      IF(TOPLOT(I)) 2D,20,1D
   1D J = TOPLOT(I)
      IPOINT = (PLOT(I) * SCALE(1)) + RAISE(J)
      IF(I.EO.5.OR.1.EO.10) J = J - 1
      IF(IPOINT.GT.BOUNDL(J).ANO.IPOINT.LT.BOUNOU(J)) POINT(IPOINT) =
     1 LETTER(I)
   2D CONTINUE
C-----WRITE THE DATE BY TENS
      1F(1OAY.EO.1D.OR.1OAY.EO.20.OR.IOAY.EO.30) GO TO 30
      WRITE (11,91D) POINT
  91D FORMAT(9X124A1)
      GO TO 4D
   30 WRITE I11,920) DATE,POINT
  92D FORMAT(1X3I2,2H..124A1)
   4D DO 50 I = 2,123
   5D POINT(1) = 1H
      POINT(42) = 1H.
      POINT(B3) = 1H.
      RETURN
      ENO
```

Subroutine RADCOMP

```
      SUBROUTINE RADCOMP
C-----COMPUTE THE POTENTIAL RAOIATION AT THE BASE STATION
C-----
C-----OICTIONARY
C
C     BETWEEN - THE TOTAL NUMBER OF OAYS BETWEEN THE RESPECTIVE
C                   LOCATIONS OF THE OATES 1N -NOATE-
C     DAYS - THE NUMBER OF DAYS THAT HAVE PASSEO SINCE THE BASE DATE
C                   I-NOATE(1SUB)-) TO BE USEO IN THE INTERPOLATION
C     FRACTON - THE FRACTIONAL PART NEEDED IN THE INTERPOLATION BETWEFN
C                   TABLE VALUES IN THE COMPUTATION OF THE RADIATION
C     ISUB - THE SUBSCRIPT OF THE BASE TABLE VALUE USED TO DBTAIN THE
C                   RAOIATION FROM THE TABLES BY INTERPOLATION
C     NOATE - THE OATES OF THE TABLES USED IN COMPUTING THE RAOIATION
C
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),CDMAX(25),COVDEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETOA1LY(25,12)
      COMMON FREEWAT(25)
      COMMON 1SOTHRMI25,2D)
      COMMON LASTUSD(25),LEVELI,LEVEL2
      COMMON MMOD
      COMMON NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,2D),PEAKWEI25,2D),PHASE(25),POTENT(24),
     1        PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBIDI25,6),SLPASP(25,24)
      COMMON TCOEFFI25),THRSHLD(25),TOPLOT(I1)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEDIDI6)
      COMMON YEARS(20),YYMMOO
      INTEGER DREAOY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHED1D
      INTEGER YEARS,YYMMDD
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,DBSHYDR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/RAD/FRACTON,1SUB
      COMMDN/WATRBAL/ETFROM,EVAPDTR,GENRO,PRECIP,RAOIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      DIMENSION BETWEEN(24),NOATE(24)
      OATA BETWEEN/13., 15., 13., 15., 14., 14., 15., 14., 15., 14.,
     1 21., 2D., 15., 14., 15., I5., 14., 15., 14., 14., 14., 14., 19.,
     2 19./
      OATA NOATE/ 110,123,2D7,220,307,321,404,419,503,518,6D1,622,712,
     1 727,810,B25,909,923,100B,1022,1105,1119,1203,1222/
C-----PLACE THIS DATE WITH RESPECT TO THE TABLES
      OO 10 I = 1,24
      IF(NDATE(I) - MMOD) 10,BO,2D
   10 CONTINUE
C-----A NORMAL TERMINATION OF THE DO LOOP MEANS THAT THIS DATE FALLS
C----- BETWEEN 12/23 AND 12/31, INCLUSIVE.  USING THE ARRAY IN CIRCULAR
C----- FASHION, 1/10 (SUBSCRIPT 1) IS THE CONTROLLING DATE
      I = 1
      GO TD 30
C-----THIS OATE FALLS BETWEEN THE ONES AT LOCATIONS I AND I-1.  IF I IS
C----- 1, USE 24 FOR I-1 SINCE THE ARRAY 1S C1RCULAR
   20 ISUB = 1 - 1
      IF(ISUB) 3D,30,40
   30 1SUB = 24
C-----OBTAIN THE 1NTERPOLAT1ON FRACTION.  START BY OETERMINING IF
C----- THIS DATE FALLS IN THE SAME MONTH AS THAT AT LOCATION I OR I-1
   40 1F(OATE(1) - INDATEIISUB)/100)) 60,50,60
C-----IT IS THE SAME AS I-1 AND IT 1S LARGER, SO SUBTRACT THE I-1 DATE
C----- TO OBTAIN THE NUMBER OF OAYS TD BE USEO FOR INTERPOLATING
   5D OAYS = MMDD - NDATEI1SUB)
      GO TO 70
C-----1T IS THE SAME AS I, BUT IT IS SMALLER, SO SUBTRACT IT FRDM THE I
C----- OATE.  THEN SUBTRACT THE RESULT FROM THE DAYS BETWEEN I AND I-1
C----- TO OBTAIN THE NUMBER OF DAYS TO BE USED FDR 1NTERPOLATING
   6D DAYS = NDATE(I) - MMOD
      DAYS = BETWEEN(1SUB) - OAYS
C-----COMPUTE THE INTERPOLATION FRACT1ON
   7D FRACTON = DAYS/BETWEEN(1SUB)
      POTRAD = POTENTIISUB) + IPOTENT(I) - POTENTIISUB)) * FRACTON
      RETURN
C-----THIS DATE IS IN THE TABLE - NO INTERPOLATION IS NECESSARY
   8D FRACTDN = D.D
      ISUB = I
      POTRAD = POTENT(I)
      RETURN
      END
```

Subroutine RDMSTR

```
      SUBRDUTINE ROMSTR
C-----READ A CARD FROM THE MASTER DECK
      COMMDN AIRTEMC(25,6)
      CDMMON CALDEF(25),CDMAX(25),COVDEN(25)
      CDMMDN DREADY(25)
      COMMDN ENGBAL(25),ET,ETOAILY(25,12)
      COMMDN FREEWAT(25)
      CDMMON ISOTHRM(25,2D)
      COMMDN LASTUSD(25),LEVEL1,LEVEL2
      COMMON MMDD
      COMMON NDAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON'ONTREES(25)
      COMMDN PEAKPPT(25,2D),PEAKWE(25,2D),PHASE(25),POTENT(24),
     1        PREWEOV(25)
      CDMMDN RECHRG(25)
      COMMDN SIMTEM1(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      CDMMDN WEIGHT(25),WSHEDID(6)
      COMMDN YEARS(2D),YYMMDO
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLDT
      INTEGER VEGTYPE
      INTEGER WSHEDID
      INTEGER YEARS,YYMMDD
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RAOLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      DIMENSION IN(8)
      EQUIVALENCE (DATE(1),IN(I))
      READ (5,91D) IN
C-----THE FORMAT DECLARATORS ARE TYPED FOR THE EOUIVALENCED WORDS OF
C----- -IN- RATHER THAN FOR THE INTEGER ARRAY 1TSELF
  91D FDRMAT(3I2,11X2F4.1,19X3F5.2)
      IF(EOF(5)) 2D,20,10
   1D MSTREOF = 1
      RETURN
   2D MMDD = (DATE(1) * 1DO) + DATE(2)
      YYMMDD = (DATE(3) * 10000) + MMDD
C-----REDUCE -PPTONDW- TO ITS VALUE BEFORE THE PRECIP FOR THIS DAY WAS
C----- ADDED IN
      PPTONOW = PPTONOW - PPTMSTR
C-----SINCE RADIATION MEASUREMENTS ARE NOT AVAILABLE, COMPUTE THE BASE
C----- STATIDN VALUE HERE
      CALL RADCDMP
      RETURN
      END
```

Program SELECT

```
      OVERLAY (OLAYS,1,0)
      PROGRAM SELECT
C-----SELECT THE METHOD OF OUTPUT AND READ THE WATERSHED PARAMETERS
      COMMON AIRTEMC(25,6)
      COMMON CALDFF(25),CDMAX(25),COVDEN(25)
      CDMMON DREADY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMDN LASTUSD(25),LEVELI,LEVEL2
      COMMON MMDO
      COMMDN NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMDN DNTREES(25)
      COMMON PEAKPPT(25,20),PEAKWEI25,2D),PHASE(25),POTENTI24),
     1        PREWEOV(25)
      CDMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCDEFF(25),THRSHLDI25),TDPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOID(6)
      COMMON YEARS(20),YYMMDD
      INTEGER DREAOY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TDPLOT
      INTEGER VEGTYPE
      INTEGER WSHEDID
      INTEGER YEARS,YYMMDD
      CDMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONDW,OBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      CDMMON/WATRBAL/ETFRDM,EVAPOTR,GENRO,PRECIP,RADIN,RAOLWN,RADSWN,
     I TEMPMAX,TEMPMIN,WATERIN
      DATA IERR/1/
C-----READ THE OUTPUT SELECTION AND CHECK FDR ERRORS
      RFAO (5,91D) I,L1,L2,NOIVSBL
  910 FORMAT(A6,1XI1,1XI1,1XI2)
      IF(I.EQ.6HSELECT) GO TO 20
   10 WRITE (6,920) I,L1,L2,NOIVSBL
```

```
  920 FORMAT(*1THE SELECT CARO (FIRST CARD IN OECK) IS INCORRECT.  EITHE
     1R IT OOES NOT HAVE THE WORD -SELECT- IN COLUMNS 1-6, THE OUTPUT OP
     2TION*/* IS NOT 2, 3 OR 4, OR THE -OATE OIVISIBLE BY- VALUE IS INVA
     3LIO*/5X*COLUMNS 1-6 = *A6/5X*OUTPUT OPTION (COL 8) =*I2/5X*ALTERNA
     4TIVE (COL 10) =*I2/5X*DATE OIVISIBLE BY (COL 11-12) =*I3/*-JOB ABO
     5RTEO*)
      CALL EXIT
   20 IF(L1.EQ.3.OR.L1.EQ.4) GO TO 50
      IF(L1 - 2) 10,30,10
C-----OPTION 2 - CHECK THE OIVISIBILITY
   30 IF(NDIVSBL) 10,10,40
   40 IF(NDIVSBL - 31) 50,50,10
   50 LEVEL1 = L1
      LEVEL2 = L2 + 1
C-----READ THE PLOT CONTROL CARD ANO CHECK FOR ERRORS
      REAO (5,930) I,TOPLOT
  930 FORMAT(A5,3X11(IX11))
      IF(I.EQ.5HPLOTS) GO TO 60
      WRITE (6,940)
  940 FORMAT(*1THE SECOND CARD IN THE OATA DECK IS NOT THE PLOTS CARD -
     1JOB ABORTED*)
      CALL EXIT
C-----HYDROGRAPH
   60 IF(TOPLOT(1) - 3) 80,80,70
   70 I = 10HHYDROGRAPH
      WRITE (6,950) IERR,I,TOPLOT(1)
  950 FORMAT(I1,*THE *A10,* MAY NOT BE PRINTED ON BASE LINE*I2,* OF THE
     1 PLOTS*)
      IERR = 0
C-----WATER EQUIVALENT
   80 IF(TOPLOT(2) - 3) 100,100,90
   90 I = 10HWATER EQV
      WRITE (6,950) IERR,I,TOPLOT(2)
      IERR = 0
C-----INPUT
  100 IF(TOPLOT(3) - 3) 120,120,110
  110 I = 10HINPUT
      WRITE (6,950) IERR,I,TOPLOT(3)
      IERR = 0
C-----EVAPOTRANSPIRATION
  120 IF(TOPLOT(4) - 3) 140,140,130
  130 I = 10HEVAPOTR
      WRITE (6,950) IERR,I,TOPLOT(4)
      IERR = 0
C-----STORAGE REQUIREMENTS (SINCE THIS IS A NEGATIVE QUANTITY, IT MAY
C----- NOT BE PRINTED AS PART OF LEVEL 1, BUT MAY BE PART OF A PSEUOO
C----- LEVEL, LEVEL 4)
  140 IF(TOPLOT(5).LT.4.ANO.TOPLOT(5).NE.1) GO TO 150
      I = 10HSTORAGE
      WRITE (6,950) IERR,I,TOPLOT(5)
      IERR = 0
C-----RUNOFF
  150 IF(TOPLOT(6) - 3) 180,180,160
  160 I = 10HRUNOFF
      WRITE (6,950) IERR,I,TOPLOT(6)
  170 CALL EXIT
  180 IF(IERR) 170,170,190
C-----BE SURE THAT ALTERNATIVES PRINT ON THE SAME LEVEL AS THEIR
C----- COUNTERPARTS
  190 00 210 I = 7,11
      IF(TOPLOT(I)) 210,210,200
  200 TOPLOT(I) = TOPLOT(I-5)
  210 CONTINUE
C-----READ THE WATERSHED DESCRIPTORS AND PARAMETERS
      CALL RDPARAM
C-----WRITE THE FIRST LINES OF THE PLOT
      REWIND 11
      WRITE (11,960) WSHEDID,NSUB
  960 FORMAT(*1*54X*WATER BALANCE SIMULATION*/
     1 1X6A10,41X*COMPOSITE OF*I3,* SUBSTATIONS*//
     2 *0*63X*LEGEND*/
     3 1X2(12X*CHAR  DEFINITION*15X*RANGE*12X)/
     4 14X*A     ALTERNATIVE RESULT FOR NEAREST CHARACTER      *
     5 10X*R     RUNOFF-SIMULATED GEN  0 TO 2.0 INCHES         */
     6 14X*E     EVAPOTRANSPIRATION    0 TO .2 INCH            *
     7 10X*S     STORAGE REQUIREMENTS  -5.3 TO 0 INCHES        */
     8 14X*H     HYDROGRAPH-OBS GENRO  0 TO .5 AREA INCHES     *
     9 10X*W     WATER EQUIV OF PACK   0 TO 30.0 INCHES        */
     A 14X*I     INPUT - MELT OR RAIN  0 TO 2.0 INCHES         */*0*)
C------RETURN TO THE MAIN OVERLAY FOR THE LOADING OF THE NEXT OVERLAY
      END
```

Subroutine RDPARAM

```
      SUBROUTINE RDPARAM
C-----READ THE WATERSHED PARAMETERS ANO DESCRIPTORS
      COMMON AIRTEMC(25,6)
      COMMON CALDEF(25),CDMAX(25),COVDEN(25)
      COMMON OREADY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSD(25),LEVEL1,LEVEL2
      COMMON MMDD
      COMMON NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMDD
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOD
      COMMON/CMPSITO/COMPS(16),YRTOT(5)
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAO,MSTREOF,IYR
      INTEGER DATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RAOLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      INTEGER PEAKOAT
      DATA IERR,N/2*1/
C-----REAO THE WATERSHED TITLE AND NUMBER OF SUBSTATIONS
      READ (5,900) WSHEDID,NSUB,NYEARS
  900 FORMAT(6A10,14X2I3)
      IF(NSUB.GE.1.AND.NSUB.LE.25) GO TO 10
      WRITE (6,901) IERR,NSUB
  901 FORMAT(I1,I3,* SUBSTATIONS MAY NOT BE RUN.  COLUMNS 76-77 OF THE W
     1ATERSHED ID CARO MUST BE 1 TO 25, INCLUSIVE (OR THE PROGRAM MAY BE
     2 REVISEO)*)
      IERR = 0
   10 IF(NYEARS.GE.1.AND.NYEARS.LE.20) GO TO 20
      WRITE (6,902) IERR,NYEARS
  902 FORMAT(I1,I3,* YEARS MAY NOT BE RUN.  COLUMNS 79-80 OF THE WATERSH
     1ED IO CARD MUST BE 1 TO 20, INCLUSIVE (OR THE PROGRAM MAY BE REVIS
     2ED)*)
      IERR = 0
C-----READ THE POTENTIAL RADIATION CARDS (2 CARDS)
   20 READ (5,910) NAME,POTENT
  910 FORMAT(A10,10X12F5.0/20X12F5.0)
      IF(NAME.EQ.10HPOTENTIAL ) GO TO 30
      WRITE (6,911) IERR
  911 FORMAT(I1,*THE POTENTIAL RADIATION CAROS DO NOT FOLLOW THE WATERSH
     1EO IO CARD*)
      IERR = 0
C-----SEE IF THERE ARE SUBSTATIONS TO BE READ
   30 IF(NSUB) 210,210,60
   60 NSETS = NSUB
C-----REAO A SET OF SUBSTATION OESCRIPTORS.  START WITH THE ID AND
C----- CONSTANT PARAMETERS
   70 READ (5,930) (SUBIO(N,I),I=1,6),TCOEFF(N),COVDEN(N),CDMAX(N),
     1 WEIGHT(N),THRSHLD(N),VEGTYPE(N)
  930 FORMAT(6A10,4F4.2,F2.0,1X11)
      IF(CDMAX(N).GE.COVDEN(N)) GO TO 80
      WRITE (6,931) IERR,(SUBIO(N,I),I=1,6),COVDEN(N),CDMAX(N)
  931 FORMAT(I1,*ON THE SUBSTATION ID CARD ENTITLEO *6A10/* THE COVER DE
     1NSITY SPECIFIED IN COLUMNS 65-68 (*F5.2,*) IS GREATER THAN THE MAX
     2IMUM COVER DENSITY IN COLUMNS 69-72 (*F5.2,*)*)
      IERR = 0
   80 IF(WEIGHT(N).GT.0.0.AND.WEIGHT(N).LE.1.0) GO TO 90
      WRITE (6,932) IERR,WEIGHT(N),(SUBID(N,I),I=1,6)
  932 FORMAT(I1,*INVALID WEIGHT (*F5.2,*) IN COL 73-76 OF SUBSTATION ID
     1CARO ENTITLEO *6A10/* WEIGHT MUST BE BETWEEN 0.001 AND 1.0, INCLUS
     2IVE*)
      IERR = 0
   90 IF(VEGTYPE(N).EQ.1.OR.VEGTYPE(N).EQ.2) GO TO 100
      WRITE (6,933) IERR,VEGTYPE(N),(SUBID(N,I),I=1,6)
  933 FORMAT(I1,*INVALID VEG TYPE I*I1,*) IN COLUMN 80 OF SUBSTATION ID
     1CARD ENTITLED *6A10/* VEGETATION TYPE = 1 (LODGEPOLE PINE), = 2 (S
     2PRUCE FIR)*)
      IERR = 0
C-----READ THE INITIAL CONDITIONS CARD
  100 REAO (5,940) NAME,SIMTEM1(N,2),PREWEQV(N),RECHRG(N),SIMTEM1(N,1),
     1 DREADY(N)
  940 FORMAT(A10,10X4F5.2,I5)
      IF(NAME.EQ.10HINITIAL CO) GO TO 110
      WRITE (6,941) IERR,(SUBID(N,I),I=1,6)
  941 FORMAT(I1,* THE INITIAL CONDITIONS CARO DOES NOT FOLLOW THE SUBSTA
     1TION ID CARD ENTITLEO*/1X6A10)
      IERR = 0
      GO TO 130
C-----CONVERT THE PACK TEMPERATURE TO CALORIE DEFICIT (AS A POSITIVE
C----- QUANTITY), INCLUDE THE WEIGHTED RECHARGE REQUIREMENT FOR USE IN
C----- THE -CHANGE IN STORAGE- COMPUTATION, AND DEFINE THE GROUND
C----- TEMPERATURE FOR THE SIMULATION MODEL
  110 CALDEF(N) = - SIMTEM1(N,2) * PREWEQV(N) * 1.27
      YRTOT(4) = YRTOT(4) + (RECHRG(N) * WEIGHT(N))
      SIMTEM1(N,3) = - 1.5
C-----READ THE DAILY ET VALUES
  130 READ (5,950) NAME,(ETDAILY(N,I),I=1,12)
  950 FORMAT(A10,10X12F5.4)
      IF(NAME.EQ.10HDAILY ET  ) GO TO 140
      WRITE (6,951) IERR,(SUBID(N,I),I=1,6)
  951 FORMAT(I1,* THE DAILY ET VALUES CARD DOES NOT FOLLOW THE INITIAL C
     1ONDITIONS CARD IN THE CARDS FOLLOWING THE SUBSTATION ID CARD ENTIT
     2LEO*/1X6A10)
      IERR = 0
C-----READ THE AIR TEMPERATURE COEFFICIENTS
  140 READ (5,960) NAME,(AIRTEMC(N,I),I=1,6)
  960 FORMAT(A10,10X6F5.3)
      IF(NAME.EQ.10HAIR TEMP C) GO TO 150
      WRITE (6,961) IERR,(SUBID(N,I),I=1,6)
  961 FORMAT(I1,*THE AIR TEMPERATURE COEFFICIENTS CARD DOES NOT FOLLOW T
     1HE DAILY ET CARD IN THE CARDS FOLLOWING THE SUBSTATION ID CARD ENT
     3ITLED*/1X6A10)
      IERR = 0
C-----READ THE SLOPE/ASPECT ADJUSTMENT FACTORS

  150 READ (5,970) NAME,(SLPASP(N,I),I=1,24)
  970 FORMAT(A6,2X24F3.2)
      IF(NAME.EQ.6HSLP/AS) GO TO 160
      WRITE (6,971) IERR,(SUBID(N,I),I=1,6)
```

```
  971 FORMAT(I1,*THE SLOPE/ASPECT CORRECTION FACTORS CARO OOES NOT FOLLO
     1W THE AIR TEMPERATURE COEFFICIENTS CARO FOLLOWING THE SUBSTATION I
     20 CARO*/1X6A10)
      IERR = 0
C-----REAO THE PEAK WATER EQUIVALENT, ITS DATE AND THE DATE BY WHICH THE
C----- PACK MUST BE ISOTHERMAL FOR EACH YEAR
  160 DO 190 I = 1,NYEARS
      REAO (5,980) PEAKWE(N,I),TEMP,PEAKDAT,ITEMP
  980 FORMAT(20X2F5.2,1X16,1X16)
C-----FOR RAPIO ANO MORE ACCURATE BINARY COMPARES IN SUBROUTINE GENOATA,
C----- LOWER THE PEAK PRECIP SLIGHTLY
      PEAKPPT(N,I) = TEMP - 0.001
      IF(N - 1) 170,170,180
  170 YEARS(I) = MOO(PEAKOAT,100)
      GO TO 190
  180 IF(YEARS(I).EQ.MOO(PEAKDAT,100)) GO TO 190
      K = MOO(PEAKOAT,100)
      WRITE (6,981) IERR,(SUBID(N,J),J=1,6),YEARS(I),K,(YEARS(J),J=1,
     1 NYEARS)
  981 FORMAT(I1,*THE PEAK W.E. CAROS FOLLOWING THE SUBSTATION IO CARO EN
     1TITLED *6A10/* DO NOT CORRESPONO TO THE YEARS AND/OR OROER OF THE
     2FIRST SET REAO.  WHEN*I3,* WAS EXPECTEO,*I3,* WAS REAO.*/* THE FIR
     3ST SET ISO*20I4)
      IERR = 0
C-----CONVERT THE ISOTHERMAL OATE TO YYMMOO FORMAT FOR RAPIO COMPARES
  190 ISOTHRM(N,I) = (10000 * ITEMP) - (999999 * (ITEMP/100))
C-----GO ON TO THE NEXT SET
      N = N + IERR
      NSETS = NSETS - 1
      IF(NSETS) 200,200,70
  200 IF(IERR) 210,210,220
  210 WRITE (6,990)
  990 FORMAT(*0*/*OJOB ABORTED FOR ABOVE REASON(S) WHILE OPERATING IN SU
     1BROUTINE ROPARAM*)
      CALL EXIT
C-----INITIALIZE THE VARIABLES THAT HAVE NOT BEEN DEFINEO ABOVE
  220 DO 230 N = 1,25
      ENGBAL(N) = -1.0
      FREEWAT(N) = 0.0
      LASTUSO(N) = 0
      NDAYSNO(N) = 0
      ONTREES(N) = 0.0
  230 PHASE(N) = 0
C-----SUM THE WEIGHTS TO CERTIFY THAT A COMPLETE SET OF PARAMETERS IS
C----- INCLUDEO
      SUM = 0.0
      DO 240 N = 1,NSUB
  240 SUM = SUM + WEIGHT(N)
      IF(SUM.GT.0.97.ANO.SUM.LT.1.03) RETURN
      WRITE (6,991) IERR,SUM
  991 FORMAT(I1,*THE TOTAL OF THE WEIGHTING FACTORS (*F6.3,*) IS OUTSIDE
     1 THE TOLERABLE TOTALS, 0.97 TO 1.03*)
      GO TO 210
      ENO
```

Program INTSUM

```
      OVERLAY (OLAYS,2,0)
      PROGRAM INTSUM
C-----INTERVAL SUMS OF VALUES CONCERNEO WITH WATER - LOAO APPROPRIATE
C----- OPERATING PROGRAM TO WORK WITH THE SUBROUTINES IN THIS OVERLAY
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVOEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLO(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEDIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER OREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOO
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYOR,
     1 POTRAO,MSTREOF,IYR
      INTEGER DATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RADLWN,RAOSWN,
     I TEMPMAX,TEMPMIN,WATERIN
      CALL OVERLAY (5HOLAYS,2,LEVEL2)
C-----RETURN TO THE MAIN OVERLAY TO TERMINATE NORMALLY
      ENO
```

Subroutine NORM2

```
      SUBROUTINE NORM2 (N)
C-----THE VERSION OF THE NORMAL SIMULATION SUMS THOSE VALUES CONCERNEO
C---- WITH WATER FOR OUTPUT ON OATES OIVISIBLE BY THE SPECIFIED NUMBER
      COMMON AIRTEMC(25,6)
      COMMON CALDEF(25),CDMAX(25),COVOEN(25)
      COMMON DREAOY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEMI(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER OREAOY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTFGER YEARS,YYMMOD
      COMMON/CMPSITO/COMPS(16),YRTOT(5)
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/PLOTS/PLOT(6)
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----MAKE THE PASS THROUGH THE WATER BALANCE ROUTINES
      CALL WATBAL (CALDEF(N),COMAX(N),COVOEN(N),OREADY(N),ENGBAL(N),
     1 FREEWAT(N),LASTUSO(N),NOAYSNO(N),ONTREES(N),PHASE(N),PREWEQV(N),
     2 RECHRG(N),SIMTEM1(N,1),SIMTEM1(N,2),SIMTEM1(N,3),TCOEFF(N),
     3 THRSHLO(N),VEGTYPE(N))
C-----CHECK THE MANOATORY ISOTHERMAL OATE
      IF(YYMMOO - ISOTHRM(N,IYR)) 20,10,20
C-----TURN OFF THE OIFFUSION MOOEL, SET THE PACK TO O C ANO AOJUST THE
C----- ENERGY BALANCE ACCOROINGLY
   10 OREAOY(N) = -1
      ENGBAL(N) = ENGBAL(N) + CALOEF(N)
      RAOLWN = RAOLWN + CALOEF(N)
      CALOEF(N) = 0.0
C-----WEIGHT ANO STORE THIS OATA
   20 WT = WEIGHT(N)
      COMPS(1) = COMPS(1) + (PREWEQV(N) * WT)
      COMPS(2) = COMPS(2) + (RECHRG(N) * WT)
      COMPS(13) = COMPS(13) + (PRECIP * WT)
      COMPS(14) = COMPS(14) + (WATERIN * WT)
      COMPS(15) = COMPS(15) + (EVAPOTR * WT)
      COMPS(16) = COMPS(16) + (GENRO * WT)
      CALL ETCOOE (ETFROM,COMPS(6))
      RETURN
      ENO
```

Subroutine WRITE2

```
      SUBROUTINE WRITE2 (K,COMPS)
C-----THIS VERSION OF THE OUTPUT ROUTINE PRINTS INTERVAL AND YEAR-TO-
C----- OATE SUMS OF ALL VALUES CONCERNEO WITH WATER
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVOEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEMI(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLO(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER DREAOY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOID
      INTEGER YEARS,YYMMOO
      COMMON/FOROATA/ FOOTNOT(26),MAXLINE
      INTEGER FOOTNOT
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYOR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      OIMENSION COMPS(12),FROM(7)
      OATA LINES/-1/
      OATA FROM/3HC  ,3H S ,3HCS ,3H  E,3HC E,3H SE,3HCSE/
      COMPS(6) = FROM(COMPS(6))
C-----OETERMINE HOW TO WRITE THE LINE
      IF(K.EQ.1H$) GO TO 10
      WRITE (6,910) K,COMPS
  910 FORMAT(1XA10,2F10.2,6X2F8.2,F8.4,1XA3,F9.2,7X2F8.2,F10.4,1X2F10.2)
      LINES = LINES - 1
      RETURN
C-----CHECK THE LINE COUNTER
   10 IF(LINES) 20,20,30
   20 WRITE (6,920) FOOTNOT,WSHEDIO,NSUB
  920 FORMAT(*0*13A10/1X13A10/*1*54X*WATER BALANCE SIMULATION*/
```

```
     1 1X6A10,41X*COMPOSITE OF*I3,* SUBSTATIONS*/
     2 *0*16X*C U R R E N T*12X*I N T E R V A L    T O T A L S*13X
     3 *-  -  -  Y E A R    T O    O A T E  -  -  -*/
     4 14X*SNOWPACK  RECHARGE*23X*EVAPOTRANS  GENERATEO*3BX
     5 *GEN    CHANGE IN*/
     6 16X*W. E.       REQ          PRECIP   INPUT         FROM     RUNOFF
     7       PRECIP   INPUT  EVAPOTRANS     RUNOFF  RECHRG RQ*/)
      LINES = MAXLINE
   30 WRITE (6,930) OATE,COMPS
  930 FORMAT(* *3I3,1X2F10.2,6X2FB.2,FB.4,1XA3,F9.2,7X2FB.2,F10.4,1X
     1 2F10.2)
      LINES = LINES - I
      RETURN
C-----OOUBLE SPACE BETWEEN YEARS
      ENTRY WRITOT
      WRITE (6,910)
      LINES = LINES - 1
      RETURN
      ENO
```

Program INTSUMO

```
      OVERLAY (OLAYS,2,1)
      PROGRAM INTSUMO
C-----OPERATING PROGRAM FOR PRINTING INTERVAL SUMS FOR THE NORMAL
C----- SIMULATION WITHOUT ANY ALTERNATIVES
      COMMON AIRTEMC(25,6)
      COMMON CALOFF(25),COMAX(25),COVDEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETOAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER OREAOY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOO
      COMMON/CMPSITO/COMPS(16),YRTOT(5)
      COMMON/FOROATA/ FOOTNOT(26),MAXLINE
      INTEGER FOOTNOT
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYOR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/PLOTS/PLOT(11)
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      INTEGER FOOTNTE(26)
      OATA FOOTNTE/260HNORMAL SIMULATION ONLY
     1
     2
     3
     4
C-----OEFINE THE FOOTNOTE
      OO 1 N = 1,26
    1 FOOTNOT(N) = FOOTNTE(N)
C-----MAXLINE = 52 - NUMBER OF ALTERATIONS
      MAXLINE = 52
C-----WRITE THE FOOTNOTE ON THE PLOT
      WRITE (11,900) FOOTNOT
  900 FORMAT(/*0*13A10/1X13A10//)
C-----REAO A MASTER CARO
   10 CALL ROMSTR
      IF(MSTREOF) 20,20,170
C-----GENERATE THE OATA AND PERFORM THE SIMULATION FOR EACH SUBSTATION
   20 OO 30 N = 1,NSUB
      CALL GENOATA (N)
      CALL NORM2 (N)
   30 CONTINUE
C-----STORE THE INFORMATION FOR THE PLOTS
      PLOT(1) = OBSHYOR
      PLOT(2) = COMPS(1)
      PLOT(3) = COMPS(14)
      PLOT(4) = COMPS(15)
      PLOT(5) = COMPS(2)
      PLOT(6) = COMPS(16)
C-----AOO THESE VALUES INTO THE INTERVAL LOCATIONS
      COMPS(3) = COMPS(3) + COMPS(13)
      COMPS(4) = COMPS(4) + COMPS(14)
      COMPS(5) = COMPS(5) + COMPS(15)
      COMPS(7) = COMPS(7) + COMPS(16)
C-----ZERO THE DAILY COMPOSITE LOCATIONS
      OO 40 N = 13,16
   40 COMPS(N) = 0.0
C-----SEE IF THIS OAY IS TO BE PRINTEO
      IF(MOO (OATE(2),NOIVSBL)) 70,50,70
C-----AOO THESE TOTALS INTO THE YEAR-TO-OATE LOCATIONS, GET THE CHANGE
C----- IN THE RECHARGE REQUIREMENTS AND PRINT THE LINE
   50 COMPS(B) = COMPS(B) + COMPS(3)
      COMPS(9) = COMPS(9) + COMPS(4)
      COMPS(10) = COMPS(10) + COMPS(5)
      COMPS(11) = COMPS(11) + COMPS(7)
      COMPS(12) = COMPS(2) - YRTOT(4)
      CALL WRITE2 (1H$,COMPS)
C-----ZERO THE INTERVAL ACCUMULATING LOCATIONS
      OO 60 N = 3,7
   60 COMPS(N) = 0.0
C-----PERFORM THE PLOTS BETWEEN APRIL 1 AND SEPTEMBER 30
   70 IF(MMOO - 401) 160,140,B0
   B0 IF(930 - MMOO) 160,90,150
C-----ON 9/30, STORE THE CURRENT RECHARGE REQUIREMENT, ZERO THE YEARLY
C----- ACCUMULATING LOCATIONS, AND RESET THE OIFFUSION MODEL SWITCHES
   90 YRTOT(4) = COMPS(2)
      OO 100 N = B,11
  100 COMPS(N) = 0.0
      OO 110 N = 1,NSUB
  110 OREAOY(N) = 0
C-----CHECK THE YEARS TO BE SURE ALL OECKS STILL CORRESPONO TO THE
C----- PARAMETER OECK
      IF(OATE(3) - YEARS(IYR)) 120,130,120
  120 WRITE (6,910) OATE(3),IYR,IYR,YEARS(IYR)
  910 FORMAT(*1THE OATA OECKS ARE OUT OF PHASE WITH THE WATERSHEO PARAME
     1TER OECK.  THE WATER YEAR JUST ENDING (19*I2,*) IS OECK NUMBER*I3,
     2 *,*/*  BUT SPECIFIEO CONOITIONS CARO NUMBER*I3,* FOR EACH SUBSTAT
     3ION IS FOR 19*I2)
      CALL EXIT
  130 IYR = IYR + 1
C-----OOUBLE SPACE BETWEEN YEARS
      CALL WRITOT (1H$,YRTOT)
      GO TO 150
C-----ON 4/1, WRITE THE OROINATE LINE
  140 WRITE (11,920)
  920 FORMAT(9X124(1H.))
  150 CALL PLOTTER
C-----ZERO THE CURRENT LOCATIONS
  160 COMPS(1) = 0.0
      COMPS(2) = 0.0
      GO TO 10
C-----ALL CAROS HAVE BEEN REAO.  IF A LINE WAS NOT PRINTEO ON THE LAST
C----- OAY PROCESSEO, OO IT NOW
  170 IF(MOO (MMOO,NOIVSBL)) 1B0,190,1B0
  1B0 COMPS(B) = COMPS(B) + COMPS(3)
      COMPS(9) = COMPS(9) + COMPS(4)
      COMPS(10) = COMPS(10) + COMPS(5)
      COMPS(11) = COMPS(11) + COMPS(7)
      COMPS(12) = COMPS(2) - YRTOT(4)
      CALL WRITE2 (1H$,COMPS)
C-----WRITE THE FOOTNOTE ON THE LAST PAGE
  190 WRITE (6,930) FOOTNOT
  930 FORMAT(*0*13A10/1X13A10)
C-----RETURN TO THE MAIN OVERLAY FOR NORMAL TERMINATION
      ENO
```

Program DAILY

```
      OVERLAY (OLAYS,3,0)
      PROGRAM OAILY
C-----COMPOSITE OAILY OUTPUT - LOAO APPROPRIATE OPERATING PROGRAM TO
C----- WORK WITH THE SUBROUTINES IN THIS OVERLAY
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVOEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETOAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSO(25),LEVEL1,LEVEL2
      COMMON MMOO
      COMMON NOAYSNO(25),NOIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBIO(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLO(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEOIO(6)
      COMMON YEARS(20),YYMMOO
      INTEGER OREAOY
      INTEGER PHASE
      INTEGER SUBIO
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEOIO
      INTEGER YEARS,YYMMOO
      COMMON/MASTER/OATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYOR,
     1 POTRAO,MSTREOF,IYR
      INTEGER OATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RAOIN,RAOLWN,RAOSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      CALL OVERLAY (5HOLAYS,3,LEVEL2)
C-----RETURN TO THE MAIN OVERLAY TO TERMINATE NORMALLY
      ENO
```

Subroutine NORM3

```
      SUBROUTINE NORM3 (N)
C-----THIS VERSION OF THE NORMAL SIMULATION MAINTAINS ALL INFORMATION
C----- NECESSARY OF THE PRINTING OF ONE LINE PER OAY FOR THE WATERSHEO
C----- COMPOSITE
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVOEN(25)
      COMMON OREAOY(25)
      COMMON ENGBAL(25),ET,ETOAILY(25,12)
      COMMON FREEWAT(25)
```

```
      COMMON ISOTHRM(25,20)
      COMMON LASTUSD(25),LEVEL1,LEVEL2
      COMMON MMDD
      COMMON NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEDID(6)
      COMMON YEARS(20),YYMMDD
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEDID
      INTEGER YEARS,YYMMDD
      COMMON/CMPSITO/COMPS(16),YRTOT(5)
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      COMMON/PLOTS/PLOT(6)
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
C-----MAKE THE PASS THROUGH THE WATER BALANCE ROUTINES
      CALL WATBAL (CALOEF(N),COMAX(N),COVDEN(N),DREADY(N),ENGBAL(N),
     1 FREEWAT(N),LASTUSD(N),NDAYSNO(N),ONTREES(N),PHASE(N),PREWEQV(N),
     2 RECHRG(N),SIMTEM1(N,1),SIMTEM1(N,2),SIMTEM1(N,3),TCOEFF(N),
     3 THRSHLD(N),VEGTYPE(N))
C-----CHECK THE MANDATORY ISOTHERMAL DATE
      IF(YYMMDD - ISOTHRM(N,IYR)) 20,10,20
C-----TURN OFF THE DIFFUSION MODEL, SET THE PACK TO 0 C AND ADJUST THE
C----- ENERGY BALANCE ACCORDINGLY
   10 DREADY(N) = -1
      ENGBAL(N) = ENGBAL(N) + CALOEF(N)
      RADLWN = RADLWN + CALOEF(N)
      CALOEF(N) = 0.0
C-----WEIGHT AND STORE THIS DATA
   20 WT = WEIGHT(N)
      COMPS(1) = COMPS(1) + (TEMPMAX * WT)
      COMPS(2) = COMPS(2) + (TEMPMIN * WT)
      COMPS(3) = COMPS(3) + (PRECIP * WT)
      IF(PREWEQV(N)) 40,40,30
   30 COMPS(4) = COMPS(4) + (ONTREES(N) * WT)
      COMPS(5) = COMPS(5) + (RADSWN * WT)
      COMPS(6) = COMPS(6) + (RADLWN * WT)
      COMPS(7) = COMPS(7) + (ENGBAL(N) * WT)
      COMPS(8) = COMPS(8) + (CALOEF(N) * WT)
      COMPS(9) = COMPS(9) + (PREWEQV(N) * WT)
   40 COMPS(10) = COMPS(10) + (WATERIN * WT)
      COMPS(11) = COMPS(11) + (EVAPOTR * WT)
      COMPS(13) = COMPS(13) + (RECHRG(N) * WT)
      COMPS(14) = COMPS(14) + (GENRO * WT)
      CALL ETCODE (ETFROM,COMPS(12))
      RETURN
      END
```

Function ROUNDF

```
      FUNCTION ROUNDF (SIGN)
C-----DETERMINE THE SIGN FOR ROUNDING
      IF(SIGN) 10,20,20
   10 ROUNDF = -0.5
      RETURN
   20 ROUNDF = 0.5
      RETURN
      END
```

Subroutine WRITE3

```
      SUBROUTINE WRITE3 (K,COMPS)
C-----THIS VERSION OF THE OUTPUT ROUTINE PRINTS ONE COMPOSITE LINE PER
C----- DAY
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVDEN(25)
      COMMON DREADY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSD(25),LEVEL1,LEVEL2
      COMMON MMDD
      COMMON NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
      COMMON WEIGHT(25),WSHEDID(6)
      COMMON YEARS(20),YYMMDD
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEDID
      INTEGER YEARS,YYMMDD
      COMMON/FORDATA/ FOOTNOT(26),MAXLINE
      INTEGER FOOTNOT
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      DIMENSION COMPS(16),FROM(7),ITEMPS(3),OUT(13),OUT1(7)
      EQUIVALENCE (OUT(1),OUT1(1))
      DATA LINES/-1/
      DATA FROM/3HC  ,3H S ,3HCS ,3H  E,3HC E,3H SE,3HCSE/
      J = 0
      IF(COMPS(14).LE.0.0) J = -1
      ITEMPS(1) = COMPS(1) + ROUNDF (COMPS(1))
      ITEMPS(2) = COMPS(2) + ROUNDF (COMPS(2))
      ITEMPS(3) = COMPS(15) + ROUNDF(COMPS(15))
      OUT(1) = COMPS(3)
      OUT(2) = COMPS(16)
      IF(COMPS(9)) 10,10,50
   10 OUT1(3) = COMPS(10)
      OUT1(4) = COMPS(11)
      OUT1(5) = FROM(COMPS(12))
      OUT1(6) = COMPS(13)
      OUT1(7) = COMPS(14)
      J = J + 7
C-----DETERMINE HOW TO WRITE THE LINE
      IF(K.EQ.1H$) GO TO 20
      WRITE (6,910) K,ITEMPS,(OUT1(I),I=1,J)
  910 FORMAT(1XA10,2X3I4,2F6.2,50XF5.2,2XF6.4,2XA3,5XF5.2,6XF5.2)
      LINES = LINES - 1
      RETURN
C-----CHECK THE LINE COUNTER
   20 IF(LINES) 30,30,40
   30 WRITE (6,920) FOOTNOT,WSHEDID,NSUB
  920 FORMAT(*0*13A10/1X13A10/*1*54X*WATER BALANCE SIMULATION*/
     1 1X6A10,41X*COMPOSITE OF*I3,* SUBSTATIONS*/
     2 *0*15X*TEMP (F)   PRECIP (IN)  INTERCEPTED  RAD (CAL) ENG BAL
     3 SNOWPACK      INPUT  EVAPOTRANS     RECHARGE   GENERATED*/
     4 5X*DATE      MAX MIN AVE   DAY ACCUM        (IN)       SW    LW  (CA
     5L)  TEMP(C) WE(IN)   (IN)  (IN)  FROM    REQ (IN)  RUNOFF (IN)*)
      LINES = MAXLINE
   40 WRITE (6,930) DATE,ITEMPS,(OUT1(I),I=1,J)
  930 FORMAT(* *3I3,3X3I4,2F6.2,50XF5.2,2XF6.4,2XA3,5XF5.2,6XF5.2)
      LINES = LINES - 1
      RETURN
C-----ALL THE INFORMATION IS TO BE PRINTED
   50 DO 60 I = 3,13
   60 OUT(I) = COMPS(I+1)
      OUT(11) = FROM(COMPS(12))
      J = J + 13
C-----DETERMINE HOW TO WRITE THE LINE
      IF(K.EQ.1H$) GO TO 70
      WRITE (6,940) K,ITEMPS,(OUT(I),I=1,J)
  940 FORMAT(1XA10,2X3I4,2F6.2,5XF6.4,3X3F6.1,4XF4.1,2XF6.2,2XF5.2,2X
     1 F6.4,2XA3,5XF5.2,6XF5.2)
      LINES = LINES - 1
      RETURN
C-----CHECK THE LINE COUNTER
   70 IF(LINES) 80,80,90
   80 WRITE (6,920) FOOTNOT,WSHEDID,NSUB
      LINES = MAXLINE
   90 WRITE (6,950) DATE,ITEMPS,(OUT(I),I=I,J)
  950 FORMAT(* *3I3,3X3I4,2F6.2,5XF6.4,3X3F6.1,4XF4.1,2XF6.2,2XF5.2,2X
     1 F6.4,2XA3,5XF5.2,6XF5.2)
      LINES = LINES - 1
      RETURN
C
C-----YEARLY TOTALS
C
      ENTRY WRITOT
C-----DETERMINE HOW TO WRITE THE LINE
      IF(K.EQ.1H$) GO TO 100
      WRITE (6,960) K,(COMPS(I),I=I,5)
  960 FORMAT(1XA10,20XF6.2,49XF6.2,F8.4,9XF6.2,4XF7.2/)
      LINES = LINES - 2
      RETURN
C-----CHECK THE LINE COUNTER
  100 IF(LINES) 110,110,120
  110 WRITE (6,920) FOOTNOT,WSHEDID,NSUB
      LINES = MAXLINE
  120 WRITE (6,970) DATE,(COMPS(I),I=1,5)
  970 FORMAT(*0TOTALS THROUGH*3I3,7XF6.2,49XF6.2,F8.4,*  (CHNG =*F6.2,*)
     1*3XF7.2/)
      LINES = LINES - 3
      RETURN
      END
```

Program DAILYO

```
      OVERLAY (DLAYS,3,1)
      PROGRAM DAILYO
C-----DAILY COMPOSITE OUTPUT, NO ALTERNATIVES
      COMMON AIRTEMC(25,6)
      COMMON CALOEF(25),COMAX(25),COVDEN(25)
      COMMON DREADY(25)
      COMMON ENGBAL(25),ET,ETDAILY(25,12)
      COMMON FREEWAT(25)
      COMMON ISOTHRM(25,20)
      COMMON LASTUSD(25),LEVEL1,LEVEL2
      COMMON MMDD
      COMMON NDAYSNO(25),NDIVSBL,NSUB,NYEARS
      COMMON ONTREES(25)
      COMMON PEAKPPT(25,20),PEAKWE(25,20),PHASE(25),POTENT(24),
     1       PREWEQV(25)
      COMMON RECHRG(25)
      COMMON SIMTEM1(25,3),SUBID(25,6),SLPASP(25,24)
      COMMON TCOEFF(25),THRSHLD(25),TOPLOT(11)
      COMMON VEGTYPE(25)
```

```
      COMMON WEIGHT(25),WSHEDID(6)
      COMMON YEARS(20),YYMMDD
      INTEGER DREADY
      INTEGER PHASE
      INTEGER SUBID
      INTEGER TOPLOT
      INTEGER VEGTYPE
      INTEGER WSHEDID
      INTEGER YEARS,YYMMDD
      COMMON/CMPSITD/COMPS(16),YRTOT(5)
      COMMON/FORDATA/ FOOTNOT(26),MAXLINE
      INTEGER FOOTNOT
      COMMON/MASTER/DATE(3),TMXMSTR,TMNMSTR,PPTMSTR,PPTONOW,OBSHYDR,
     1 POTRAD,MSTREOF,IYR
      INTEGER DATE
      COMMON/PLOTS/PLOT(11)
      COMMON/WATRBAL/ETFROM,EVAPOTR,GENRO,PRECIP,RADIN,RADLWN,RADSWN,
     1 TEMPMAX,TEMPMIN,WATERIN
      INTEGER FOOTNTE(26)
      DATA FOOTNTE/260HNORMAL SIMULATION ONLY
     1
     2
     3
     4
C-----DEFINE THE FOOTNOTE
      DO 1 N = 1,26
    1 FOOTNOT(N) = FOOTNTE(N)
C-----MAXLINE = 52 - NUMBER OF ALTERATIONS
      MAXLINE = 52
C-----WRITE THE FOOTNOTE ON THE PLOT
      WRITE (11,900) FOOTNOT
  900 FORMAT(/*0*13A10/1X13A10//)
C-----READ A MASTER CARD
   10 CALL RDMSTR
      IF(MSTREOF) 20,20,130
C-----GENERATE THE DATA AND PERFORM THE SIMULATIONS FOR EACH SUBSTATION
   20 DO 30 N = 1,NSUB
      CALL GENDATA (N)
      CALL NORM3 (N)
   30 CONTINUE
C-----WRITE OUT THE COMPOSITE LINE
      COMPS(15) = (COMPS(1) + COMPS(2)) * 0.5
      COMPS(16) = COMPS(16) + COMPS(3)
C-----CONVERT THE CALORIE DEFICIT TO A PACK TEMPERATURE
      IF(COMPS(9).NE.0.0) COMPS(8) = - COMPS(8)/(COMPS(9) * 1.27)
      CALL WRITE3 (1H$,COMPS)
C-----ADD THESE VALUES INTO THE YEARLY TOTALS
      YRTOT(2) = YRTOT(2) + COMPS(10)
      YRTOT(3) = YRTOT(3) + COMPS(11)
      YRTOT(5) = YRTOT(5) + COMPS(14)
C-----STORE THE INFORMATION FOR THE PLOTS
      PLOT(1) = OBSHYDR
      PLOT(2) = COMPS(9)
      PLOT(3) = COMPS(10)
      PLOT(4) = COMPS(11)
      PLOT(5) = COMPS(13)
      PLOT(6) = COMPS(14)
C-----PERFORM THE PLOTS BETWEEN APRIL 1 AND SEPTEMBER 30
      IF(MMDD - 401) 110,90,40
   40 IF(930 - MMDD) 110,50,100
C-----ON 9/30, PRINT THE YEARLY TOTALS, ZERO THE ACCUMULATED PRECIP AND
C----- RESET THE DIFFUSION MODEL SWITCHES
   50 YRTOT(1) = COMPS(16)
      YRTOT(4) = COMPS(13) - YRTOT(4)
      CALL WRITOT (1H$,YRTOT)
      YRTOT(4) = COMPS(13)
      YRTOT(2) = 0.0
      YRTOT(3) = 0.0
      YRTOT(5) = 0.0
      COMPS(16) = 0.0
      DO 60 N = 1,NSUB
   60 DREADY(N) = 0
C-----CHECK THE YEARS TO BE SURE ALL DECKS STILL CORRESPOND TO THE
C----- PARAMETER DECK
      IF(DATE(3) - YEARS(IYR)) 70,80,70
   70 WRITE (6,910) DATE(3),IYR,IYR,YEARS(IYR)
  910 FORMAT(*1THE DATA DECKS ARE OUT OF PHASE WITH THE WATERSHED PARAME
     1TER DECK.  THE WATER YEAR JUST ENDING (19*I2,*) IS DECK NUMBER*I3,
     2 *,*/*  BUT SPECIFIED CONDITIONS CARD NUMBER*I3,* FOR EACH SUBSTAT
     3ION IS FOR 19*I2)
      CALL EXIT
   80 IYR = IYR + 1
      GO TO 100
C-----ON 4/1, WRITE THE ORDINATE LINE
   90 WRITE (11,920)
  920 FORMAT(9X124(1H.))
C-----PERFORM THE PLOT, THEN ZERO THE COMPOSITE LOCATIONS
  100 CALL PLOTTER
  110 DO 120 N = 1,14
  120 COMPS(N) = 0.0
      GO TO 10
C-----ALL CARDS HAVE BEEN READ.  IF THE DECK ENDED ON 9/30, ALREADY
C----- CAUSING THE WATER YEAR TOTALS TO PRINT, JUST END THE JOB.  BUT ON
C----- ANY OTHER DAY, PRINT OUT THE YEAR TO DATE TOTALS HERE
  130 IF(MMDD - 930) 140,150,140
  140 YRTOT(1) = COMPS(16)
      YRTOT(4) = PLOT(5) - YRTOT(4)
      CALL WRITOT (1H$,YRTOT)
C-----WRITE THE FOOTNOTE ON THE LAST PAGE
  150 WRITE (6,930) FOOTNOT
  930 FORMAT(*0*13A10/1X13A10)
C-----RETURN TO THE MAIN OVERLAY FOR NORMAL TERMINATION
      END
```

Leaf, Charles F., and Glen E. Brink.
1973. Hydrologic simulation model of Colorado subalpine forest. USDA For. Serv. Res. Pap. RM-107, **23** p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521.

A simulation model specifically designed to determine the probable hydrologic changes resulting from watershed management in the Colorado subalpine zone is described. The model simulates the total water balance on a continuous year-round basis and compiles the results from individual hydrologic response units into a "composite overview" of an entire drainage basin. Preliminary results are summarized for an 8-year test period on a 667-acre experimental watershed.

Oxford: 116.21:U681.3. **Keywords:** Computer models, coniferous forest, forest management, model studies, simulation analysis, snowmelt, subalpine hydrology, vegetation effects, watershed management.

Leaf, Charles F., and Glen E. Brink.
1973. Hydrologic simulation model of Colorado subalpine forest. USDA For. Serv. Res. Pap. RM-107, **23** p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521.

A simulation model specifically designed to determine the probable hydrologic changes resulting from watershed management in the Colorado subalpine zone is described. The model simulates the total water balance on a continuous year-round basis and compiles the results from individual hydrologic response units into a "composite overview" of an entire drainage basin. Preliminary results are summarized for an 8-year test period on a 667-acre experimental watershed.

Oxford: 116.21:U681.3. **Keywords:** Computer models, coniferous forest, forest management, model studies, simulation analysis, snowmelt, subalpine hydrology, vegetation effects, watershed management.

Leaf, Charles F., and Glen E. Brink.
1973. Hydrologic simulation model of Colorado subalpine forest. USDA For. Serv. Res. Pap. RM-107, **23** p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521.

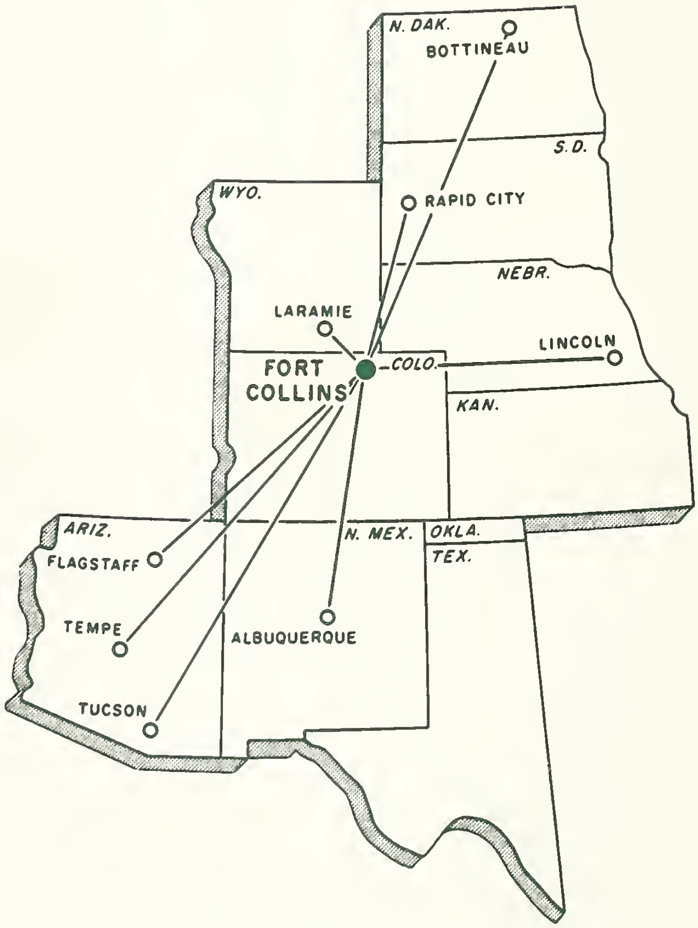
A simulation model specifically designed to determine the probable hydrologic changes resulting from watershed management in the Colorado subalpine zone is described. The model simulates the total water balance on a continuous year-round basis and compiles the results from individual hydrologic response units into a "composite overview" of an entire drainage basin. Preliminary results are summarized for an 8-year test period on a 667-acre experimental watershed.

Oxford: 116.21:U681.3. **Keywords:** Computer models, coniferous forest, forest management, model studies, simulation analysis, snowmelt, subalpine hydrology, vegetation effects, watershed management.

Leaf, Charles F., and Glen E. Brink.
1973. Hydrologic simulation model of Colorado subalpine forest. USDA For. Serv. Res. Pap. RM-107, **23** p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521.

A simulation model specifically designed to determine the probable hydrologic changes resulting from watershed management in the Colorado subalpine zone is described. The model simulates the total water balance on a continuous year-round basis and compiles the results from individual hydrologic response units into a "composite overview" of an entire drainage basin. Preliminary results are summarized for an 8-year test period on a 667-acre experimental watershed.

Oxford: 116.21:U681.3. **Keywords:** Computer models, coniferous forest, forest management, model studies, simulation analysis, snowmelt, subalpine hydrology, vegetation effects, watershed management.


N. DAK.
BOTTINEAU
S.D.
WYO.
RAPID CITY
NEBR.
LARAMIE
LINCOLN
FORT COLLINS
COLO.
KAN.
ARIZ.
N. MEX.
OKLA.
TEX.
FLAGSTAFF
TEMPE
ALBUQUERQUE
TUCSON